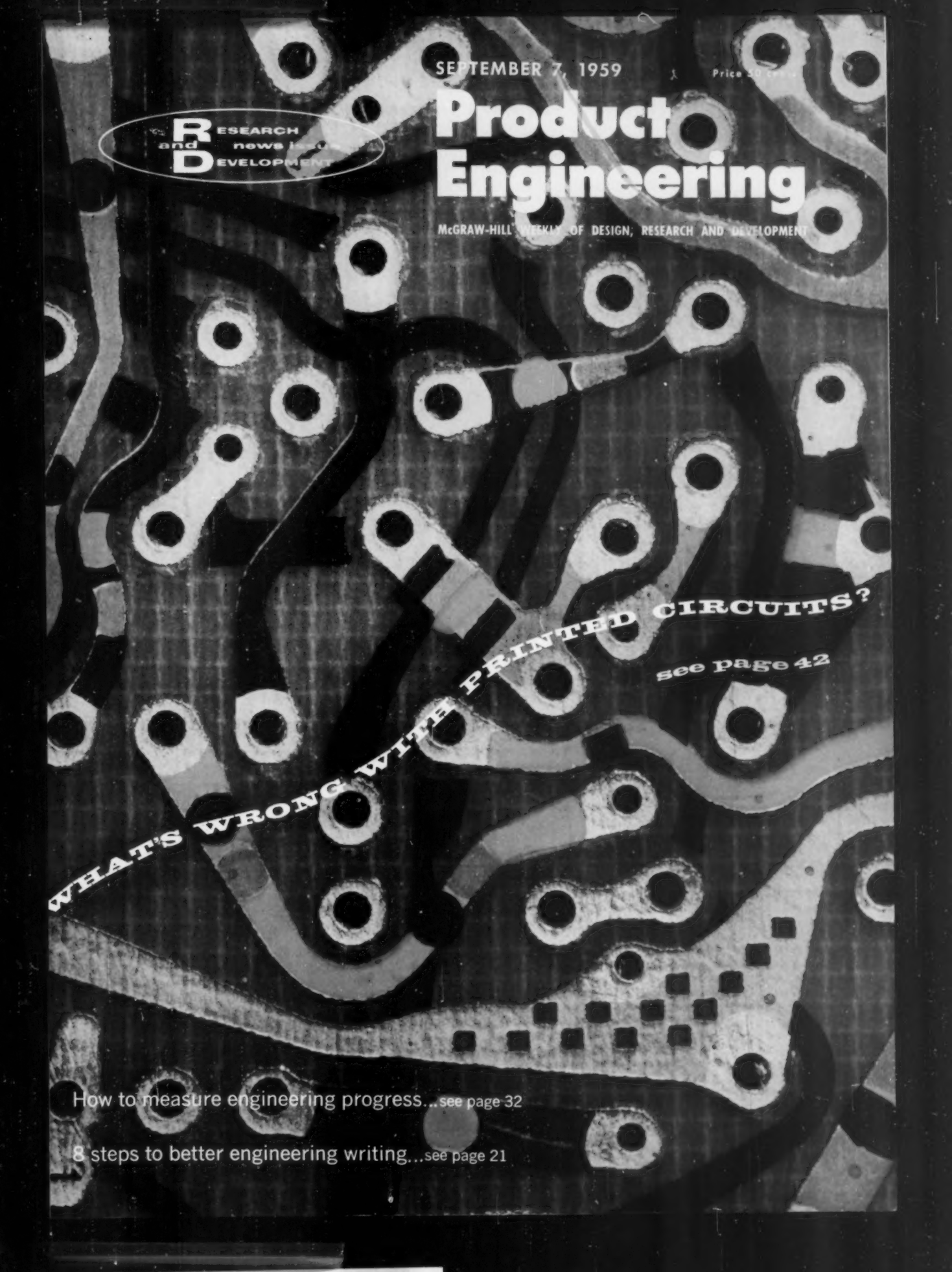
SEPTEMBER 7, 1959
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R and D RESEARCH and news of DEVELOPMENT
Product Engineering
McGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT
WHAT'S WRONG WITH PRINTED CIRCUITS?
see page 42
How to measure engineering progress...see page 32
8 steps to better engineering writing...see page 21

3M COMPANY CHEMICALS

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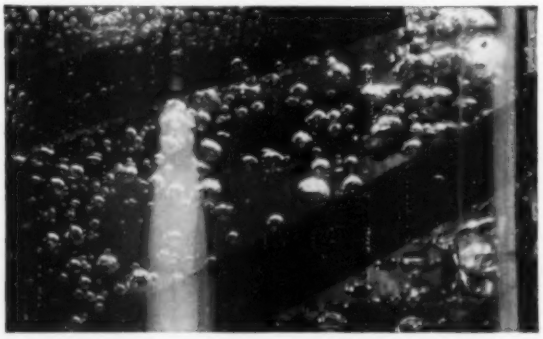
EASE OF PROCESSING is shown by this disc. Note the reproduction of machine marks from mold surface. FLUOREL Elastomer can be readily mold processed on standard rubber compounding and fabricating equipment. It may be molded, extruded and bonded to most metals.



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CHEMICAL DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

. . . WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

WRITE 76 ON READER SERVICE CARD

IN THIS ISSUE
the first in an exclusive series of articles

8 *steps to better engineering writing*

- A down-to-earth guide for engineers in their daily working assignments.
- Immediate practice in revising, simplifying, fashioning more powerful

. . . **memos,**
. . . . . **letters,**
. . . . . **reports,**
. . . . . **proposals.**

- How to make your ideas concise, simple, clear.

Start the first lesson on page 21.
See how vanity and laziness destroy most good writing. Practice simplifying five typical examples of engineer's writing.

The series starts this week and will continue in each issue of **Product Engineering** until Oct. 26. Next week, in the Design issue for Sep 14

Lesson 2: Be Positive; be brave

coming next week

the DESIGN issue for September 14

FEATURING

- **To test ball bearing performance**
  These special and commercial devices check bearings for torque, vibration and runout.

- **When equipment says it in color**
  How and where design can use color functionally. How color vision works.

- **Painless drawing changes**
  Even a small design department should set up a non-engineering service group to control changes.

- **Residual stresses in gears**
  A survey method determines which hardening treatment and combination of materials for better gears.

- **New data for high-pressure air**
  Properties for extended ranges up to 12,000 psi and —150 to 250F

- **Bevel-gear calculations**
  A worksheet for quick solutions to several of the design formulas.

- **13 handles for instruments**
  From custom-made, molded-to-fit types to makeshift handles of pipe.

Product Engineering

McGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT

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Product Engineering ..... SIDELIGHTS

R and D research and development news issue

● **The printed-wiring debate,** much like Detroit's engine-in-the-rear fracas, signals a disturbing trend in salesmanship. Advertising and publicity men are using engineer's opinions, rather than their designs, to cut competitor's throats. The lay public is supposed to be impressed and make intelligent (that is, guided) choice between TV sets, one of which has every joint "customized by hand soldering", while another is "untouched by human hands for maximum reliability." The opinions on page 42 are by engineers and for engineers. Copywriters please pass them by.

● **Project control with forms, or even computers,** (p 32) should not let you neglect the project engineer's most important problem. Merritt A. Williamson, dean of Penn State's College of Engineering, says project managers supervise relationships, not people or projects. If there are three men in your group, you supervise the relationships between you and engineers A, B, and C, plus A-B, B-C, and A-C, for a total of six relationships. If your work load is too heavy and you decide to get an assistant, *he adds four more relationships.* So unless his assistance is needed for mechanical rather than supervisory tasks, you will be much better off without the extra "help."

● **Engineers create outright antagonism** for their profession, company, and country every time they put pencil to paper. Their public debates are misquoted and misunderstood; their articles and society papers need interpreters; their letters are as readable as insurance policies. As professional writers as well as engineers, we have neglected our responsibilities and we're going to do something about it. In this issue (p 21), we've started a series of articles designed to teach better writing. It will be followed up by a course in science writing by our chief copy editor, William Gilman, at Columbia's School of General Studies this fall. Other schools and companies may be interested in setting up their own courses. Let us know and we'll do what we can to help.

September 7, 1959

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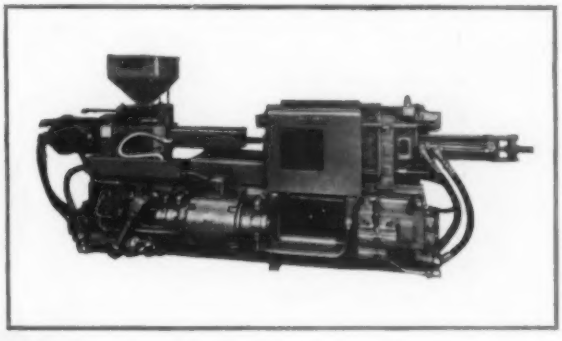
FOR EXAMPLE, the Reed-Prentice injection molding machine, shown at right, had been using a standard 40-hp motor. By ECONO-MATCHING, G-E engineers determined that a smaller, lighter, more compact 30-hp motor with improved electrical characteristics could do the job required. Although this special 30-hp motor cost slightly more than a standard 30-hp, it provided greater efficiency and cost considerably less than the 40-hp motor it replaced. It also cut space and weight requirements. G-E has also ECONO-MATCHED motors for crane, compressor, and other applications.



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Moraine Products
Division of General Motors, Dayton, Ohio

DEVELOPMENTS TO WATCH... American

New resins for service at 500 F . . .

. . . can be made by copolymerizing silicone and epoxy resins, say J. R. Bond and S. A. Brady of Dow Corning Corp. In glass-cloth laminates, these resins have excellent structural properties (as measured by flexural strength) and maintain them after long-term aging at 500 F. As one example, glass-cloth laminates made at 30 psi by standard procedures, and showing a flexural strength in the range of 75,000 psi at room temperature, have shown a room-temperature strength of 55,000 psi after 200 hr at 500 F, and 35,000 psi while still hot.

Bond and Brady will describe the materials at next week's ACS meeting; and there will be more than a dozen other papers on epoxy resins and coatings.

(Note: For more news of this meeting, see p 12 and next issue.)

"Unwanted" information has become such a serious problem . . .

. . . in communications and control that it's slated for major research attention by both government and industry groups.

It may take the form of meaningless dots on a radar screen, background "noise" that disturbs radio-telescope pickups, or nonessential sounds that add to the complexity of voice transmission and compound the problems of designing voice-actuated command controls for machine tools.

The nuclear field has its "unwanted" information too–background radiation that confuses detectors and counters.

In all these fields, research contracts are being prepared or have already been signed. In some, production of special equipment is already under way. Airborne Instruments Laboratory, Div of Cutler-Hammer Inc, for instance, has an $8-million contract to produce Video integrators that will eliminate the clutter—both natural and man-made, accidental and intentional–from radar screens. This equipment, says AIL, is expected to minimize interference by radar energy returned from the ground or air (by birds, insects, and meteorological disturbances), electronic jamming or the generation of spurious targets, and local noise sources like motors and communications systems. That's a big order, but it's typical of the requirements now being posed for design of equipment in many fields.

The Tesla turbine may be revived . . .

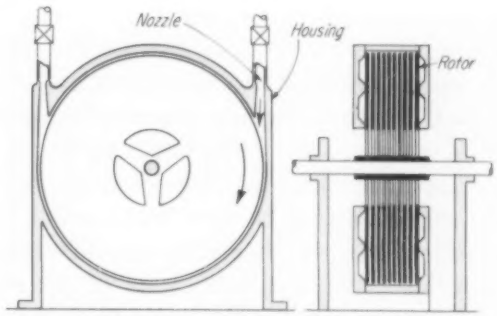
. . . as a high-speed power source. Recent research, says Texas Engineering Experiment station, indicates that this long-neglected design may serve as a basis for lightweight, compact, efficient power production.

Far less familiar than the Tesla electric motor (PE–July 6, p 5), to which it bears some striking resemblances (note laminations), the turbine is unusual because it gets all its power from fluid friction, a source of relatively large losses in other turbines.

As the diagram shows, the rotor is made of a series of thin, flat disks keyed to a shaft. Openings in the disks serve as exhaust ports. Almost any gas or fluid can serve as a working medium. The gas or fluid is given high velocity by a nozzle tangent to the rotor, flows between the disks from the outside to the center, then exhausts parallel to the shaft. The large number of disks and their close spacing develop the large frictional force.

Tesla's first model, says TEES, weighed only 10 lb but produced 30 hp at 20,000 rpm. An experimental unit about 4 in. in dia, with 10 disks, built at TEES, reached 48,000 rpm with no apparent adverse effects.

Preliminary data obtained from operation of this turbine indicate that a straight-line torque-speed relationship will be characteristic of units of this type; and overall performance will be largely dependent on the velocity of the entering fluid. As yet, no work has been done on the effects of varying disk spacing and nozzle angle; but studies of such factors are now being planned.



Friction turbine features disk-type construction, is lightweight, easy to produce, can be reversed simply by adding another set of nozzles pointed in the opposite direction.

A new division of
The Dow Chemical Company—

THE DOW METAL PRODUCTS COMPANY

Here's significant news for everyone who has an interest in metals and metal fabrication. The Dow Chemical Company, pioneer developers of Magnesium and Magnesium products, is now broadening its activities in metal working. A new division, THE DOW METAL PRODUCTS COMPANY, has been formed to specialize in the semi-fabrication and fabrication of not only Magnesium, but aluminum and other metals. This new division has excellent production facilities, plus knowledge gained through Dow's many years' experience in the metal working field. Facilities include plants for the manufacture of rolled and extruded products, sand and permanent mold castings, die castings, and fabricated assemblies.

DOW THE DOW METAL PRODUCTS COMPANY
DIVISION OF THE DOW CHEMICAL COMPANY
MIDLAND, MICHIGAN

DEVELOPMENTS TO WATCH...

World-wide

High-efficiency, low inertia miniature dc motors . . .

. . . with small time-constant and unusually low starting speeds are claimed by Brion, Leroux & Cie, Paris, France.

The company has developed two types: one, for measuring, takes advantage of the fact that the no-load speed is directly proportional to the voltage applied. The other is for driving small mechanisms. Both feature dual windings in the form of a hollow bell, and neither has a rotating magnetic element. The stators are permanent magnets, rigidly fixed inside the armature.

The first type has twin windings, each with a starting current of 1 milliamp; a continuous current of 50 milliamp, and a rating of 50 v at 3,000 rpm. Resistance is 350 ohms; maximum power output 3.5w. Time-constant is about 100 millisec. It is intended for use with a magnetic amplifier or tube amplifier as a current source.

In the second type, the windings differ so that one (armature resistance: 700 ohms; voltage: 100v; power output: 6 watts) serves as the motor; while the other (resistance: 15 ohms; 8½ v at 3,000 rpm) provides a dc voltage that is proportional to the angular speed and can be used for stabilizing servomechanisms for telemetering, remote-control systems, and the like.

Bronze bearings will cost less to produce . . .

. . . and still retain all their desirable properties, say G. R. Bell, F. B. Webb and B. Woolfall of Powder Metallurgy Ltd, when new atomized copper powders are used in place of electrolytic materials. Furthermore, tests of bearings made with atomized tin as well as copper powders show they are in some cases even preferable to the standard types—and cost of manufacture is appreciably lower. They say the atomized copper powders have low apparent density and are unusually stable in storage; and photomicrographs show them to be "remarkably similar to those prepared by reduction of copper oxide."

One of the atomized copper powders, known as Grade NLD, is now in commercial production for use in porous bronze bearings.

Improved conductive paints for printed circuits, static eliminators . . .

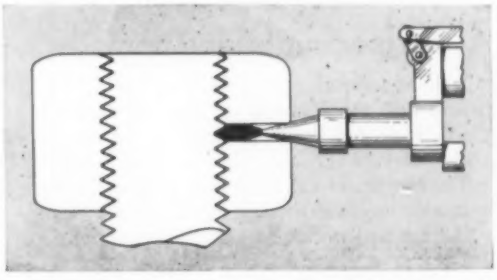
. . . and other electrical applications, are promised by a West German firm which says it now has a metallic pigment that offers "the conductivity of noble metals," and is not impaired by heat or moisture. With a suitable binder, the company says, coatings resistant to temperatures well over 400 F can be made. These paints require no additional electrolyte; and are said to have withstood tests in industrial atmospheres at relative humidities as high as 95%. Aniline dyes can also be incorporaed in them.

Another application foreseen for these Kontaktogran pigments: incorporation in plastics sheeting to prevent static buildup.

Eckart-Werke, Furth/Bayr, developed the materials and is to produce them commercially.

Adhesive-locked nut . . .

. . . being made in Sweden by A. B. Wilmut, Tulegatan 20, Stockholm, uses a plastic paste, forced into the bolt-nut interspace under pressure (100 atmos) after assembly, as the locking mechanism. A small hole is provided in the side of the nut for the purpose (see diagram); and the nut is given its final tightening after the adhesive is in place. The adhesive is of a non-curing type which maintains a degree of plasticity so that the assembly can be unscrewed if desired and reassembled with a little additional material. Use of locking sealants in themselves is not new, of course, but the company believes that this design, with its prepared hole, is. —ARG



Sealant is injected under pressure to hold nut securely in place. Non-hardening compound permits disassembly and reassembly if desired.

DEVELOPMENTS TO WATCH...

Washington

Look for more defense contracts . . .

to be chopped in the next few weeks. To keep within the $41-billion budget level, the military is forced to weed out marginal projects. Cuts coming now are needed for both this fiscal year and the next few years ahead.

For the first time in several years, military spending is expected to remain fairly stable over the next three to four years at its present $41-billion level. But, to accomplish this, there has to be a tightening up now. Next year, for example, dollar outlays would increase by another $1-billion beyond the $41-billion budget level if current production rates and R & D schedules were left unchanged.

This accounts for recent contract cancellations even though the immediate dollar savings aren't too large. It is over the long haul that they add up. The Air Force and Navy's cancelllation of the J93-5 engine and chemical fuels contracts for example, amount to only a savings of some $50-million in fiscal 1960. Over the next few years, however, $100-million to $200-million would have been needed for the program.

Navy's cancellation of its P6M Seamaster contract with the Martin Company after 9 of the 14 planes ordered were delivered is designed to save another $72-million.

Air Force's cut of eight B-58 planes will save at least $100-million. It is just this type of whittling at costs that can be expected to continue. So far, basic research contracts have not been largely affected by the Defense Department's dollar squeeze. But, even these are likely to tighten in the next few years. Programs will have to show real promise before dollars are pumped into them. There will be more decisions between rival projects, too. Primarily, this is expected to come in the missile programs.

It all means that although defense spending stays at a $41-billion level the competition for the defense dollar is going to get tighter and many projects underway now are going to be squeezed out.

A new series of government patents . . .

are now available. Abstracted in seven booklets by technical field, the patents represent several hundred released for licensing between July 1955 and June 1958.

Titled Supplement No. 2, Patent Abstract Series, the order numbers and costs are listed below for the new series.

Two previous Patent Abstract Series have been issued. One in 1956 covering patents licensed between 1954 and June 1955; and the other for patents prior to December 1953.

The abstracts give the general scope of an invention, then if a person wants specifications on a particular patent these can be obtained from the Commissioner of Patents for 25 cents. A license can be obtained to produce the item from the government agency administering the patent as shown in the abstract series.

Government patent licenses are issued on a royalty-free, non-exclusive basis.

Here are the new abstract series available from the OTS, US Department of Commerce, Washington 25, DC.

PB 151506 Instrumentation, $1.25; PB 151507 Chemical Products and Processes, 50 cents; PB 151508 Food Products and Processes, 50 cents; PB 151509 Metal Processes and Apparatus, Machinery and Transportation Equipment $1.25; PB 151510 Electrical and Electronic Apparatus, $1.75; PB 151511 Ordnance, 75 cents; PB 151512 Ceramic, Paper, Rubber, Textile, Wood and Other Products and Processes, 50 cents.

A thermocouple anemometer . . .

capable of measuring air velocity as low as 5 to 10 ft/min with simultaneous readings coming from 15 to 20 points has been developed by the Bureau of Standards.

The equipment was needed for a study the agency is conducting to determine the air flow in refrigerated truck trailers that haul chilled and frozen foods.

The low readings from the anemometer are obtained by using lighter conducting materials—Nichrome and constantan—for the thermocouple element to achieve a stabilized electronic circuit.

The equipment must give 15 to 20 simultaneous readings in an area with roughly 1000 cu ft of material.

The purpose of the Bureau of Standards study is to determine what effect the different ways of loading a frozen food trailer have on its ability to maintain adequate transporting temperatures. The tests are expected to take two years to complete.

The bureau has just completed a similar two-year study to develop a system of measuring the heat loss characteristics of refrigerated trailers.

For the engineer who refuses to stagnate

HALF the world is half asleep! Men who could be making *twice* their present salaries are coasting along, hoping for promotions but doing nothing to bring themselves forcefully to the attention of management.

They're *wasting* the most fruitful years of their business lives . . . throwing away thousands of dollars they may never be able to make up. And, oddly enough, they don't realize—even remotely—the tragic consequences of their failure to forge ahead while time is still on their side.

Engineers and other technically-trained men are particularly prone to "drift with the tide" because their starting salaries are reasonably high and promotions come at regular intervals early in their careers. It isn't until later—too much later in many cases—that they discover there is a definite ceiling on their incomes as technicians.

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WHAT'S HAPPENING IN... Science

Stress is ennobling

Metals under tension tend to become more noble; while metals under compression tend to become less noble, say Carnegie Institute metallurgists.

The shift in electrode potential is not great—on the order of 0.01 to 0.1 mv/1000 psi of applied load—but it is larger and different in character from theoretical predictions. For that reason, it is of considerable interest. (According to prevailing theory, the shift should be in the less-noble direction in both torsion and compression; and should be not greater than 10^{-4} or 10^{-6} mv.)

The CIT researchers say the effect has been observed in copper, gold and sheet silver and iron wire.

Mild steel and high-purity (single-crystal) iron apparently do not follow the general rule. They seem to become slightly less noble under tension by bending, and slightly more noble under compression.

Of the suggested explanations for the observed changes, the most satisfactory one so far, they believe, is a thermodynamic one that relates the observed effects to "transport of interstitial impurities between metal electrode and electrolytic solution." Hydrogen ion seems the most likely impurity. This would explain why high-purity metals do not behave in the same way.

As the CIT researchers are careful to point out, the actual corrosive effect of the shift in electrode potential is negligible. Only extremely high stresses, such as those which occur about line imperfections, would contribute appreciably to the corrosion of metals or alloys. But the shift is important on a theoretical basis.

Bootstrap reactor enters second stage

A reactor that will "make" part of its own fuel is moving through its design stages with neat precision. Atomics International announces plans to build a reactor core mock-up for the Advanced Epithermal Thorium Reactor (AETR).

This is a 360,000-ekw design being studied by and for a group of 15 southwest utilities. It is planned to use a thorium-uranium fuel, sodium coolant, and beryllium or graphite moderator. The "bootstrap" feature lies in the fact that excess neutrons released by the uranium are captured by the thorium, converting this element into another fissionable uranium isotope.

If more atoms of the second isotope are produced than are "burned" in the initial fission process, the reactor is termed a "breeder" and may actually produce excess fissionable material which can be used in other reactors. In the AETR, this goal may not quite be achieved. But the system is, at least, expected to help itself out and reduce operating costs by producing a substantial part of the fissionable material it needs; and work is progressing on reactors that will, in fact, produce excess fissionable material.

brief . . .

Boiling sulfur will cool another new reactor (see above)—if engineering problems can be solved. Use of sulfur, which boils at 1200 F, should permit high thermal efficiency; but there's a lot to be learned about sulfur's properties and reactions. AEC thinks enough of the idea, though, to enter into contract negotiations with Aerojet's Nucleonics Div, which proposed it. —ARG

Taking pictures of sound

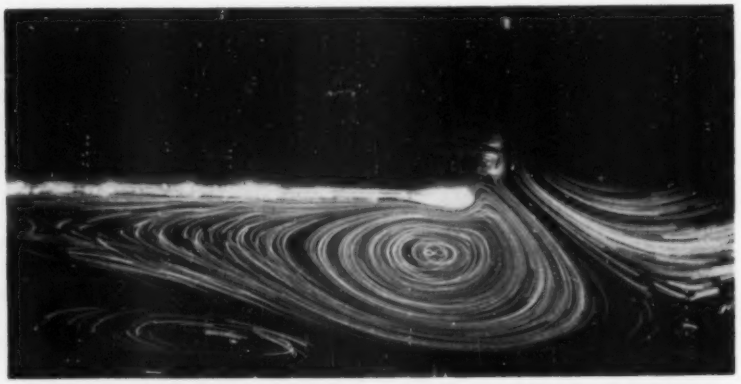
Photomicrographs that show the micro-eddying or "acoustic streaming" that is created when a metal rod is vibrated ultrasonically in a liquid are being taken with a novel apparatus at Brown University.

The aim: to find out more about how high-frequency vibrations promote chemical and physical reaction on solid surfaces and membranes.

The apparatus: a metal bar (about 50 in. long for 2kc vibrations), set in a transparent dish filled with a glycerine-water mixture containing tiny (10 to 100 microns) polystyrene beads that serve as motion indicators. The rod is provided with interchangeable plastic caps which make it possible to vary the shape of the tip, a factor which seems to have an important effect on the observed results.

The liquid is illuminated (dark light) from the side and observed and photographed through a microscope, with the results shown here.

At least three circulation patterns have been uncovered and theoretical studies are now under way.



Micro-eddying created by high-frequency sound waves is pictured by Brown U. photo.

WHAT'S HAPPENING IN... Materials

When resins won't stick

If plastic coatings won't adhere to metal, the fault may lie in the processing of the plastic—not in the basic properties of the resin itself or in the adhesion system—says J. J. Bikerman of MIT's Adhesives Lab. He finds, for instance, that polyethylene, traditionally a non-stick material, can be made to cling tenaciously to metal and may actually be used as adhesives if low molecular weight components and oxygenated compounds are removed. This can readily be done, either by fractional precipitation or by solvent extraction.

The reason, he theorizes: these components form surface films on the resin which interfere with adhesion and result in the formation of weak boundary layers, much as oxides do on the surface of many metals.

When polyethylene is treated to remove the objectionable impurities, peeling tensions as great as 91 ounces/in. (a million dynes per cm) have been observed. Furthermore, the treated resin also shows much improved printability.

Neither tensile strength nor melting range of the resin is significantly altered by the treatment. However, there are revealing changes in the infrared spectrum which indicate that the low molecular weight components are indeed the culprits.

More on those high-temp polymers

We are on the threshold of important discoveries in the area of thermally stable polymers . . . so says A. M. Lovelace of the Wright Air Development Center Materials Lab, the group which is coordinating much of the industrial and government research in this area (*PE—July 7 '58, p 17 and July 13 '59, p 9*).

There are no materials yet which are ready for—or even close to—commercial production. But participants in the Air Force program report exciting developments like these:

- Polymers, with aluminum-oxygen-aluminum "backbones," that are stable in the 550 to 750 F range.
- Organo-metallic coordination polymers—derivatives of hydroxy-quinoline and the aminophenols, combined with copper, zinc, and other metallic ions—which should show excellent heat resistance if a high-enough order of polymerization can be achieved.
- Linear phosphoborines, stable in the 500 to 750 F range and similar in appearance and many properties to polyethylene.

As Dr Lovelace points out, the problem of achieving a high-enough order of polymerization is a critical one for all of these materials. But the project is certainly on its way.

4 ways to improve thermal insulation

Design techniques that can boost the efficiency of thermal insulating materials 2 to 10 times were described by speakers at the U of California's Cryogenic Engineering Conference last week. The emphasis here, of course, was on ultralow temperatures; but many of the ideas have much broader application. Here are a few examples:

- Multi-layer materials in which good reflectors alternate with poor conductors produce systems "10 times more efficient than the best evacuated powder insulation" say National Bureau of Standards cryogenic engineers. The effective thermal conductivity (k-factor), of such materials they say, is less than 26 x 10^{-6} Btu/hr/ft/°F. Of the combinations so far tried, aluminum foil and glass fiber paper seem best; but a number of others are under test.
- Evacuation of closed-cell plastic foams to remove residual gases can improve their performance, too—reducing their apparent mean thermal conductivity to a value "one-third to one-half that of ordinary, unevacuated plastic foams," said L. R. Stoecker of Beech Aircraft. A mechanical system is being devised to do the job.
- Evacuation also increases the insulating efficiency of glass mats, H. M. Strong of GE reported. Flat panel thermal insulation made with evacuated glass mats shows an efficiency "comparable to a Dewar flask."
- Insulation-filled plastic honeycombs have 3 times the insulating value of loose fibrous insulation, NASA researchers find. For space flights, the honeycomb structures offer one disadvantage, though: they're about 4 times as heavy as the fibrous materials.
- Even powdered materials can be improved in thermal insulating power, not only by evacuation techniques, but also by reducing powder size, other speakers noted; size is also a factor in glass fiber insulation.

briefs . . .

Rare-earth elements aplenty are promised by Bureau of Mines research on bastnaesite ores, rich in cerium, lanthanum, praesodymium, neodymium, and samarium; and present in deposits "extensive enough to supply a greatly expanded market for many years." A calcining process, though still in an "embryonic stage of development" looks like a simple, efficient and "economically acceptable" method for separating out individual elements and is already supplying samples on a laboratory scale. Further work is planned, both on the calcining process and on the elements themselves.

(Note: For information on how these elements may be used, see *PE—Jan 27 '58, p 7 and Oct 20 '58, p 11*).

Purer silicon metal with better electrical properties is promised by a spate of new producers. Several companies already offer solar grade; but the new entries promise ultrapure metal with vastly improved semiconductor properties. Among the newcomers: Monsanto, now building for commercial production; DuPont, in pilot plant; Dow Corning, studying the field. —ARG

Foils must be light—they must be steel There was a time when your very life depended upon and tough enough to spring back unharmed after countering the intended death blow. These characteristics have

STEELS FOR DESIGN-

your blade. It had to be as light as human ingenuity could make it. But it also had to be strong,

made steel the most important metal in the history of man. For some modern, lightweight examples, turn the page ▷ ▷ ▷

CHAPMAN TRANSPORT INC.
COMPRESSED GAS

STEELS FOR DESIGN

Stainless Steel builds a stronger, lighter trailer. This 40-foot trailer is one of the latest models designed and built by the Fruehauf Trailer Company. It's the strongest, lightest trailer in its class because it was built with Stainless Steel. The Stainless has a yield point of 120,000 psi, almost four times greater than competitive materials, so the walls, roof, and braces could be made thin and very light, yet they are rigid and strong. The exceptional corrosion resistance of Stainless Steel practically eliminates maintenance. This trailer will never have to be painted or refinished and it will still look clean and new after many thousands of miles.

High Strength Steel cuts cable reel weight 25%. The George Evans Corporation is the largest manufacturer of cable reels in the United States. Each of these reels has to carry and protect about $5000 worth of cable—seven tons of it. The reel must be strong and rugged or it will buckle under its load as it bumps over rocks and timbers in the field. It must *also* be exceptionally light, or freight costs will be exorbitant and field handling almost impossible. For a long time, these reels were made of wood and they lasted about two years. Then, the company started to make an all-steel reel, with the rims made of USS COR-TEN High-Strength Low-Alloy Steel. The COR-TEN Steel reels are much stronger and they weigh 25% less than wooden reels. They *cost less,* too, because they cut freight charges; they practically eliminate maintenance; and they will last about twenty years.

USS "T-1" Alloy Steel cuts tanker weight, increases payload. Trinity Steel Company of Dallas, Texas, makes LPG transport tankers and recently the company tripled production to meet the demand for its new, lightweight models. Trinity increased the payload of these tankers substantially by cutting the weight of the carrier itself as much as one-third. They used USS "T-1" Constructional Alloy Steel. Because "T-1" Steel is extremely strong—100,000 psi minimum yield strength—the tank walls are made about ⅓ thinner—with a comparable reduction in weight. And the weldability of "T-1" Steel meets the rigid ASME code that requires X-Ray and magnetic particle inspection of all joints.

USS, "T-1" and COR-TEN are registered trademarks

United States Steel USS

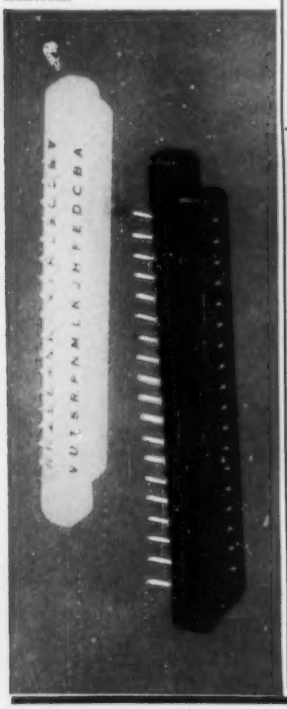
Plaskon Nylon News

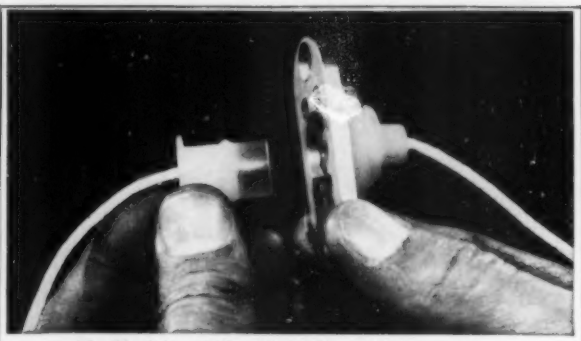
Type 6 • Nylon's Range of Applications Expands!

MORE AND MORE INDUSTRIAL AND CONSUMER PRODUCTS MAKE USE OF ITS OUTSTANDING PROPERTIES

Durable Electrical Circuits

Space Products, Long Beach, Calif., uses flexible Plaskon Nylon 8200 for circuit connectors because it produces higher uniformity of finished parts yet lowers manufacturing costs. These "Ezi-Connectors" feature beryllium contacts, with a fatigue resistance twice as great as that of spring brass or phosphor bronze. They are moisture-proof and can be easily and repeatedly inserted and removed. Available in several colors, they are lettered to permit easy assembly and identification.





Reliable Missile Fire Connector

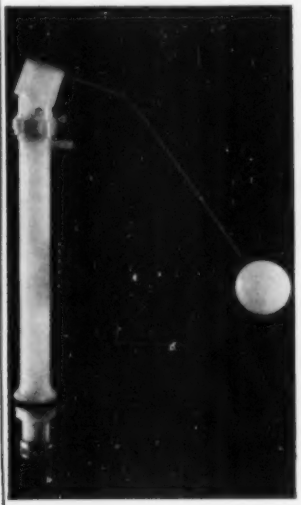
Plaskon Nylon 8200's outstanding durability, light weight and resilience are put to good use in this missile fire connector. Injection molded nylon provides excellent insulation and seal against contaminants and moisture for the connector's contacts, as well as mechanical protection for the unit itself. The manufacturer, Alden Products, Brockton, Mass., reports that Plaskon Nylon 8200 enables him to achieve the highest compactness and reliability for this vitally important missile component.

High Strength Closures

This smooth, lustrous Plaskon Nylon cap nut will not scratch, snap or tear other surfaces as do metal caps. Ideal for use in the furniture and electronics industries, the "Relok" Nut is rust-proof, antimagnetic and self-locking. Plaskon Nylon's high strength and impact resistance enable it to withstand rugged duty. The Lehigh Metal Products Company, Cambridge, Mass., supplies the "Relok" Nut in several lengths and colors.

Superior Ballcock Valve

The Hydo Valve Corporation, Austin, Texas, manufactures this ballcock toilet valve with injection molded Plaskon Nylon 8200. The valve's superior action cuts water closet fill time in half and eliminates noise and seepage. Plaskon Nylon is ideal for products of this type because of its high resistance to heat, chemicals and abrasion. Also, nylon's light weight produces a more compact unit, which can be more economically stored and shipped.



Extra Extrusion Economy! Plaskon Nylon Extrusion Compound 8205 maintains high-melt viscosity through successive regrinds. Scrap can be re-extruded several times without the slightest deterioration of basic properties.

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PLASTICS AND COAL CHEMICALS DIVISION

40 Rector Street, New York 6, N.Y.

Allied Chemical

Product Engineering HORIZONS

September 7, 1959

YOU, TOO, CAN WRITE / *or can you?*

Back in the black days of 1932, "consulting engineer" was a pseudonym for an engineer out of a job. One very competent "consultant" took on a pay-out-of-savings job—his income was to be a percentage of what he saved his new employer. As is so often true with the unsentimental outsider, he found a number of places where substantial savings could be made. But, three erudite reports-to-the-president later, there was no evidence that any of his ideas had even gotten a hearing, let alone been implemented.

A growling stomach is quite an incentive, so he went to the president. He was right; all of his reports had been put aside until the president "had time." Why? The reports all followed standard form, stating the objective, the procedure, the method of investigation, and finally the conclusions. The president had started each one, but finding no initial money-saving content, had put each aside in turn.

"But," the idea man protested (as he told me later). "The first report alone concludes with savings of $100,000!"

"Good Lord, Man," exclaimed his boss, "Why didn't you say so at the beginning?"

The report maker was afflicted with a familiar ailment—he wrote logical, well-thought-out reports that matched his orderly mind, but were deadly dull. He had failed to realize that he was writing for an audience of one—a busy, sales-minded executive who inherently hated to read. The president could be caught and held only by prose that told him in the first few words how much money it would save him.

That engineer recast his reports to suit his audience. He dropped the fancy words that proved how smart he was, the tedious explanations that proved how long he'd worked and how profoundly he'd thought, and told a busy man how to save a buck. He's now the president himself.

This problem is in our minds as we begin a series of eight short articles on how to write a report. The idea came from a reader who liked our series on how to read (Jan 5, 12, 19, 26, Feb 2 '59). We've read enough engineering reports, articles and papers to see the need. The fact that more than 7,000 readers have asked for reprints of the earlier series suggested rather pointedly the need and treatment. The experts and laymen who've seen the series like it. So here it is.

Author Dick Koff has no illusions—he has probably violated most of his own rules in the articles proposing them. He has not been exhaustive. He hasn't followed the traditional format. He hasn't provided the unbeatable formula for a report. But he *has* been terse and to the point. He has tried to deal with today's problems, as you face them.

These eight quick lessons will not make you a Lincoln or a Shakespeare; you can guarantee *that* only by proper selection of grandparents and proper development of all your years up to now. You, in short, must have the mind and heart of a genius to write for the ages.

But that isn't your immediate problem—or ours. We've got to write so the desired audience reads and profits *now*. So do you.

Want fast, economical solutions to your heating problems?

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Your Chromalox Representative—the man with the answers to your heating problems, routine or unusual—has over 15,000 standard types, sizes and ratings to choose from. Many of these are stocked in quantity for immediate shipment. Moreover, Chromalox has the design and manufacturing facilities to promptly build special elements to fit your special requirements, plus a complete range of controls and accessories. For instance . . .

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8 *steps to better engineering writing...*

1 . . VANITY AND LAZINESS, BE SIMPLE
2 . . BE POSITIVE, BE BRAVE
3 . . BE PERSONAL, BE SPECIFIC
4 . . BE CONCISE, DON'T OVERSTATE
5 . . VOCABULARY, GRAMMAR, PUNCTUATION
6 . . TABLES, FIGURES, CAPTIONS
7 . . WHERE TO PUT WHAT
8 . . SIT DOWN AND WRITE

RICHARD M. KOFF, *senior associate editor*

Lesson . . 1

Vanity and laziness, in that order, are to blame for most bad writing. For some reason, anyone who has learned to read assumes he has learned to write as well. Criticism or revisions are therefore felt to be direct attacks on the author's education or intelligence.

In industry, writing ability is assumed to improve automatically with authority and salary. The president's letters and reports are corrected by no one; the junior engineer's by everyone.

So . . . your first and most important step in learning to write is to swallow some pride. Your golden words will be improved by your boss, by your assistant, even by your secretary. If you really want to learn to write, you must learn to evaluate their criticisms objectively—not react like a wounded bull.

Laziness is a factor, because most people feel that writing a report or a letter is a necessary evil, not an end in itself. Anyone can do it, so it should take no time or effort.

Actually writing is as much thinking work as it is the use of grammar, or spelling, or punctuation. You need imagination (What is my reader interested in? . . . How well does he know the subject?). Logic (What ideas shall I present first? . . . What is the next step?), and perseverance (How can I get my point across faster?). But it is boring to have to go over old territory again, and it can be disconcerting if the mental review reveals gaps in your own knowledge.

So laziness combines with pride to say, "It's enough. It's right. I wrote it and understand it, so will the reader. Thank you, Miss Jones; that will be all."

To break this train of reasoning (or emotion, really) you must recognize that writing is time-consuming, productive work. It is respectable and demanding, and good writing can have almost as much influence on customers, suppliers, associates, and prospects as your company's service or product itself.

HOW TO REVISE

It is usually easier to edit than it is to write; hindsight is better than foresight. In editing you take an involved or complex sentence and reduce it to its bare essentials. You then add complexities, but only if they are necessary to meaning.

In its simplest form, the English sentence consists of subject and predicate; or subject, verb and object. For clarity, positive statements in this form can't be beat. Furthermore, subjects and predicates are nouns and verbs. The English language is so rich that good nouns and verbs need few modifiers. Adjectives and adverbs are often used to make up for poor selection of words in the first place.

Here is an example of a complex sentence and its revision step by step:

> The field of stress analysis is one in which model studies have often been used successfully. (Understandable, but backwards somehow.)
>
> Models have often been used successfully in the field of stress analysis. (Gets the subject up front. Eliminates "one in which.")
>
> Models have been used for stress analysis. (Reduced to bare essentials. Are "often" and "successfully" necessary modifiers?)

At this point editing stops. The author must determine his exact shade of meaning. How about:

> Models are useful for stress analysis.

NOW YOU TRY

The following five sentences were written by engineers in letters or reports. Note that you have to read some of them two or three times before you understand what is happening to what. By changing the order of the words or splitting a complex sentence into two or more simple sentences, can you edit them into better writing? Our versions (by no means the only way they could be written) will be found below.

1 . . Familiarity with the method whereby arithmetic operations can be performed is highly desirable.

2 . . The cutting of tubes that will have practically no burr has posed quite a problem to manufacturers for years.

3 . . To obtain the best possible results in the application of induction heating it is sometimes necessary to modify the design of the part to suit the characteristics and practical requirements of this method of heating.

4 . . The choice of the correct alloy is of prime importance and it will be found that a great deal of trouble can be prevented if all details are taken into consideration and if any doubt should arise, one should submit his questions to the Technical Department.

5 . . The base metal of an ornament may very well be an inexpensive imitation even when the surface is highly reflective and of a rich-looking finish.

1 . . Know how to do arithmetic.
2 . . It is difficult to cut tubes without leaving burrs.
3 . . Modify the part for induction heating.
4 . . Alloy choice is critical. When in trouble ask an expert.
5 . . (This is a sleeper.) All that glitters is not gold.

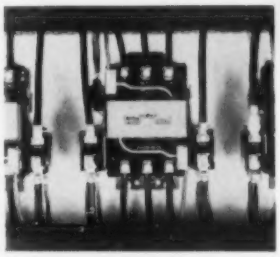
***Reprints** of this series will be available at the end of October. To reserve your copy, Circle P15 on the Readers Service Card.*

NEW General Electric Size 2 Magnetic Starter

WILL FIT INTO THIS SPACE

Save 34% on panel space; get all the fast installation features of G.E.'s 100-Line

You see here the actual amount of panel space which is occupied by a new General Electric Size 2 Magnetic Starter in the 100-Line design. Here are just a few of the benefits you can expect from the new design:



SAVE PANEL SPACE—General Electric Size 2 starter features front-accessible wiring, coil, contacts and overload relays, eliminating the "extra" panel space often required for these operations. Lower coil watts give less heat, and coil inrush current has been reduced so you can use a 33% smaller control transformer.

SAVE ASSEMBLY TIME—This 55% lighter-weight starter is fast and simple to install. Straight-through wiring eliminates run-around wiring that takes extra time and space. To mount, just slide the keyholes over three mounting screws on the panel. You'll easily save assembly time.

GREATER DEPENDABILITY—Exclusive General Electric wedge-action contacts provide positive "make." Less armature mass and spring-loaded contacts practically eliminate contact bounce, provide longer contact life. A new arc trap design attracts arcs away from contacts and dissipates both arc and ionized gases.

EASY MAINTENANCE—Like the rest of General Electric's 100-Line magnetic starters, the Size 2 can be disassembled in 20 seconds, and contacts can be visually inspected in ten seconds. Your customers get simplified maintenance.

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GENERAL ELECTRIC

Ordnance Releases R & D Thinking to Encourage Industry Participation

NEW YORK—A flow of development ideas is being funneled by private industry to the Ordnance Corps of the Army. This situation results from a pre-procurement program instituted by Ordnance about a year ago; a program entitled, "Qualitative Development Requirements Information," which welcomes any qualified company, large or small (even an individual) to participate.

Unique in Army R & D procurement circles, QDRI releases, for the first time, Army thinking about its present and future needs in all kinds of weapons and other Ordnance materiel. These needs arise from the 14 Ordnance Corps command centers, or arsenals, which have specific design missions (see chart). The 11 district offices of the Corps serve as clearing houses for introducing prospective developers to the arsenals as well as functioning as security check points.

HERE'S THE PROCEDURE

A procurement office such as the New York district office located here at 770 Broadway compiles lists of likely companies, or individuals, who appear to have experience in development work. To such prospects, the district office will write an introductory letter explaining QDRI.

If the prospect expresses an interest in the program by replying to the introductory letter, the district office will set about checking out the prospect's qualifications for undertaking such development.

One Ordnance Corps district official, describing what his office looks for when investigating a prospective developer, says: "We're most interested in technical background, and, of course, financial stability. Not that it has to be a large operation; we've accepted firms consisting of a mere 5 or 6 employes. But we must be sure of the existence of technical ability to follow through on the original idea."

Specifically, a qualified organization is defined by Ordnance as "any US individual, firm, partnership, corporation or other type of civilian organization which has (1) expressed a desire to participate in Ordnance R & D, (2) obtained the required individual and facility security clearances, (3) presented acceptable evidence of an adequate R & D capability and (4) finished the required signed copy of

Arsenals and District Offices for QDRI

Arsenals:

Ammo testing
Commanding General
Aberdeen Proving Ground
Maryland

Special fuzes
Commanding Officer
Diamond Ordnance Fuze Laboratories
Connecticut Avenue & VanNess St. NW
Washington 25, D. C.

Fire control and optics
Commanding General
Frankford Arsenal
Bridesburg Station
Philadelphia 37, Pennsylvania

Engines and accessories
Commanding General
Ordnance Tank-Automotive Command
1501 Beard Street
Detroit 9, Michigan

Ammo and special devices
Commanding Officer
Picatinny Arsenal
Dover, New Jersey

Artillery
Commanding Officer
Watervliet Arsenal
Watervliet, New York

Missile testing
Commanding General
White Sands Missile Range
Las Cruces, New Mexico

Ballistic & Pure R&D
Commanding Officer
Office of Ordnance Research
Box CM, Duke Station
Durham, North Carolina

Artillery weapons
Commanding General
Ordnance Weapons Command
Rock Island, Illinois

Small arms
Commanding Officer
Springfield Armory
Springfield 1, Massachusetts

Artillery
Commanding Officer
Watertown Arsenal
Watertown 72, Massachusetts

Heavy weapons
Commanding Officer
Rock Island Arsenal
Rock Island, Illinois

Ballistic missiles
Commander
Army Ballistic Missile Agency
Redstone Arsenal, Alabama

Missiles
Commanding Officer
Army Rocket & Guided Missile Agency
Redstone Arsenal
Huntsville, Alabama

District Offices:

Commanding Officer
Birmingham Ordnance District
2120 Seventh Avenue
Birmingham, Alabama

Commanding Officer
Boston Ordnance District
Boston Army Base
Boston 10, Massachusetts

Commanding Officer
Cincinnati Ordnance District
Swift Building
230 East Ninth Street
Cincinnati 2, Ohio

Commanding Officer
Cleveland Ordnance District
Lincoln Building
1367 East Sixth Street
Cleveland 14, Ohio

Commanding Officer
Los Angeles Ordnance District
55 South Grand Avenue
Pasadena, California

Commanding Officer
New York Ordnance District
770 Broadway
New York 3, New York

Commanding Officer
San Francisco Ordnance District
1515 Clay Street, Box 1829
Oakland 12, California

Commanding Officer
Philadelphia Ordnance District
128 North Broad Street
Philadelphia 2, Pennsylvania

Commanding Officer
St. Louis Ordnance District
4300 Goodfellow Blvd.
St. Louis 20, Missouri

Commanding Officer
Detroit Ordnance District
574 East Woodbridge
Detroit 31, Michigan

Commanding Officer
Chicago Ordnance District
6123 South Wabash Avenue
Chicago 5, Illinois

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a Policy Agreement for Release of QDRI and Army Ordnance.

Upon qualifying, the prospect is requested to execute the aforementioned policy agreement with the appropriate Ordnance District office. The agreement stipulates that the government will furnish all available and pertinent information in the way of documents "to assist the undersigned organization in evaluating where that organization may most logically seek active participation in the Ordnance R & D activity."

Once cleared and having signed the agreement, the prospect receives from the appropriate arsenal, or arsenals, general information as to Ordnance engineering needs which in most cases covers a wide range.

If still interested, the prospect advises the arsenal as to the particular area in which he wishes to make a proposal. In turn, the arsenal will send to the prospect a release describing the specific needs of Ordnance in the designated area of interest.

From the release, the company can then prepare an evaluation, or prospectus, which, according to the policy agreement, must be submitted to the arsenal within 90 days following receipt of the release—in some cases, more time is allotted. Additional information, and often it is classified information, is made available to the company directly from the arsenal on a "need-to-know" basis. In the case of Army Rocket & Guidance Missile Agency, Redstone Arsenal, where 3 separate releases covering one area of interest drew 143 industry participants, special briefings were conducted for the interested companies.

One arsenal whose over-all design mission is related mostly to missiles typifies the broadened needs of Army Ordnance when it appends to its release of areas of interest this paragraph: 1. Miscellaneous supporting research as required by material development responsibilities, including other fields not specifically mentioned above, such as radiochemistry, electricity, electronics, mechanics, dielectrics, ceramics, magnetism, microwaves and other wavelength of the electro-magnetic spectrum, solid state physics, high energy system ballistics, gas mechanics, mathematics, physiology, and psychology. These fields find application, as appropriate, to the development of long term storage methods, instrumentation, environmental testing, shock and vibration studies, materials engineering, radar and night vision, mechanical and electronic computer components, and power controls. Human engineering and patents evaluation are also R & D responsibilities of this military installation.

The resulting prospectus will be a crucial one for the private company because, after evaluating it, the Ordnance Command decides whether or not the project warrants issuing an R & D contract to carry it through.

However, if the report does not resolve the problem for the arsenal, Ordnance is not out of pocket (except for nominal expenses) as a result of the 3 months design study.

STILL US-OWNED

If the idea is accepted and Ordnance decides to issue a development contract, there's no guarantee that the originating firm will be awarded the contract, though he obviously has a better than fair chance. In this respect the program is extremely beneficial to all parties concerned. It avoids expensive development contracts which, on occasion, saddle the government with time-consuming, costly failures. At the same time, it affords a wider range of US industry to participate in the competition of ideas which become more and more precious as the needs of a futuristic army expand.

Whenever ideas do result in R & D contracts, the government, of course, get the normal royalty free rights to use the ideas and the information which are verified or "reduced to practice" under the terms of the contract.

Areas of interest are unlimited. According to an Ordnance Corps official, "There is no, and I repeat, no material in which we're not interested."

According to Victor Rosell, chief of Facilities and Resources Branch, Operations Division, NY District Office, response to QDRI here has been encouraging. "During the past year, we've processed some 600 companies that expressed interest in the program. So far, we've found a 20% yield from the variety of firms wanting to participate."

Ordnance officials say that to date approximately 2000 expressions of interest in the program have been received at the 14 Ordnance installations which handle various portions of R & D.

Other branches of the Army have expressed an interest in QDRI, and have been briefed by Ordnance.

Of most significance to private industry is Army's apparent willingness to release heretofore closely guarded

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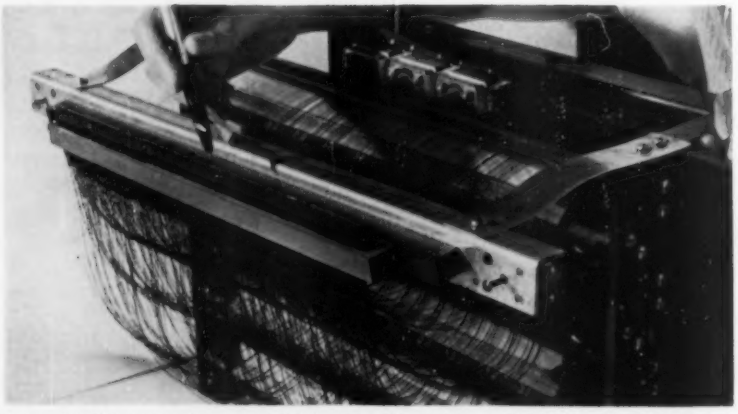


Bank of 1024 styluses is one of the keys to the super speed of the advanced digital plotter developed by Lockheed Missiles and Space Division. Use is to transcribe the millions of bits of missile and satellite performance data into finished graphs for engineering analyses. Plotter takes the processed data from an advanced IBM 708 computer and turns it into a finished plot complete with printed annotations in one completely automatic operation. Old plotter, using a single stylus, took 3-4 hr to plot one curve; new plotter does job in 40 sec.

"classified" material which could only be divulged to industry under firm contractual agreement. Prior to establishment of this procedure, very often companies would embark on expensive developmental programs without the initial guidance now provided. Now Army seeks, in the words of Marvin Dinsmore, chief of QDRI office at Army Ballistic Missile Agency, Redstone Arsenal, to eliminate "inbreeding" in military thinking by asking industry to present ideas.

Since the district office now can make security checks on prospective contractors, Ordnance is satisfied that its security interests will be guarded. Too, the developer gets an opportunity now to better educate himself far in advance of specific contract time. If he solves the problem, he has an inside track for winning a development contract. If he doesn't win the contract, he has still gained valuable experience in the field. ■

end

NASA May Change Patent Policy

WASHINGTON—Next session of Congress will probably be asked by the NASA to let companies keep more patents developed under contracts for space projects. General counsel John A. Johnson told the house space committee in exploratory hearings it is "basically unfair" to treat industry differently on Defense Department and NASA contracts. Defense allows the contracting company to keep patent rights except for government use; NASA retains almost all patents.

Johnson said it is difficult to tell whether some companies have declined to bid on NASA contracts because of the patent provisions, but admitted that in every case where it has been an issue in negotiations the agency has succeeded in placing the contract on favorable terms.

Rep James Fulton (D-Penna) said the original purpose of NASA's "tough" patent policies was to prevent any one company from getting exclusive rights in a new field where development is essential to national security. Other members feel this consideration may be outweighing the need for "uniformity" among the different agencies. ■

Slow Research Growth Deplored by Japanese

TOKYO—Many Japanese are worried about the quantity and quality of scientific research and engineering underway on their islands. This is why two new reports have appeared, each devoted to various aspects of the nation's technical effort. One, by the Science and Technology Agency, deals with industrial research; the other, by the Science Council of Japan, with basic research.

STILL US-OWNED

Industrial research, the Science and Technology Agency finds, is on the upswing, and rising more rapidly than industrial production—but still not fast enough to fulfill the nation's needs. (Industrial production rose 53% between 1954-57; research, 91%). The STA based its opinion on a survey of 942 companies which showed that R & D in 1957 amounted to $87.3 million (*PE—June* 22, p 40). This research is bulked largely in chemical and electrical machinery industries and in a few small companies.

The study also showed that Japanese industry hired 17,400 scientists in 1957—about 5.9% of the nation's industrial employment. The Japanese point out that though they lag the West in financial support of technical creation, they don't look so bad where human effort is concerned. The US does 80 times more R & D, but has only 9 times as many scientists. Great Britain does 5 times the R & D with only twice the scientists.

On the whole, the report finds, Japanese industry is gaining confidence in home-grown technology. Heretofore, management has turned to foreign science and engineering for leadership. Even so, the report concludes, reliance on foreign technology is too great. At present Japan is paying out $38 million for foreign licenses, and getting back only $383 thousand from licensees.

In determining how much money to put into research, Japanese companies generally try to establish some relationship between research and sales. Industry as a whole turns 0.8% of sales back into research. Some do much more—machinery 2.2%, chemicals 1.5% and measuring instruments, 1.5%.

Authors of the report were gratified to learn that R & D, though roughly geared to sales, was nevertheless somewhat independent of the brief ups and downs of business. During the sales decline of 1958, R & D is estimated to have risen to $102 million from $87.3 million the year before.

Japanese industry obtains relatively small monetary support from government—less than $2.5 million for all industry (see chart). This contrasts sharply with the West where defense programs strongly influence product development. In a rare case of industry-government cooperation, a microwave TV relay system resulted.

Industry has certain problems, the report notes, in trying to enlarge research effort. Primary among these is a dearth of financial resources for de-

JAPANESE RESEARCH IS INCREASING

Industries	1954	1957	Gov't Support, 1957
Chemical	$16.0	$26.1	$0.86
Electrical Machinery	12.7	20.0	0.50
Iron & Steel & Nonferrous	3.6	9.5	0.09
Transportation Equipment	3.9	7.2	0.34
Textiles	1.5	3.6	0.01
Machinery	2.1	3.4	0.13
Ceramics & Quarrying	1.8	3.0	—
Pulp & Paper	1.0	1.7	—
All Industry	45.7	87.3	2.36

veloping radical techniques once they have come out of research. Also, most small companies and some large firms are having a struggle getting enough competent technical employes.

BASIC RESEARCH

The White Paper on Basic Research, released by the Japan Science Council, presents an honor roll of Japanese scientists who deplore inadequate financial support for basic research and the primitive—occasionally even unsafe—equipment in present facilities. Many of these scientists have traveled abroad, and draw unfavorable comparisons between facilities and financial backing given basic research in the West and here in Japan. They also emphasize that the nation's professional development would be speeded by permitting more scientists to travel abroad for technical sessions.

The present disparity between availability and need for facilities and personnel could best be eased, many of these specialists say, by creating a few well-equipped research centers around the country, rather than trying to improve duplicate facilities in all universities and research institutes at

The present dearth of facilities is illustrated by the fact that the only nuclear equipment for research in Japan is located at the Univ of Tokyo's Institute for Research on Quantum-statistical Theory of Matter and at the Univ of Osaka. The only equipment for research on low-temperature physics is at the Institute of Metallic Research at Tohoku. Recently the Ministry of Finance refused equipment asked by Tokyo and Osaka for low-temperature research. ■

Minus 458 F Used for Component Testing

Tests of components for advanced electronic countermeasures systems are carried on by Sperry Gyroscope Company in a bath of liquid helium, within a heavily insulated cylinder called a cryostat. Sperry's countermeasures division, which is equiping the B-52 with a "bag of electronic tricks" never before used, is unlocking cryogenics secrets to automatically confuse enemy radar, deceive missiles and aircraft. At temperatures approaching absolute zero metals become super-conductors of electricity, allowing a current to flow forever without adding power.

Lack of Measurement Standards Challenges Critical Weapon Reliability

GREAT NECK, NY—Extensive improvements in the American system of measurement standards are now being acted upon as a result of a recent study of measurement problems in American industry. The survey was conducted by the Sperry Gyroscope Co for the Aerospace Industries Association in cooperation with the Air Force and the National Bureau of Standards. Among actions prompted by the survey are steps to:

- Adopt nationally uniform methods and procedures for transfer of calibrations from primary standards to working standards used by industry and military operation.
- Expansion of calibration services of NBS to make essential measurement accuracies more readily available to key industry and military users.
- Programming for better education, training and communications in the field of measurements and standards to insure against future deficiencies in the nation's system of standards.

"The improvements called for in the AIA survey will benefit not only the space industry but the entire economy," said Dr R. D. Huntoon, deputy director of NBS. "They would raise the standards of engineering design and reliability for everyday products that are already beginning to flow from rocket research."

VITAL 10 CATEGORIES

Major causes of the "measurement pinch" are attributed to the overwhelming revolution in measurements caused by the extremely rapid progress in the space age. Modern technology has created a myriad of new measurement quantities and is requiring toler-

A Look-see at Queen Bee

Bee Aviation's V-tailed, 4-passenger Queen Bee has completed FAA flight tests. As a safety feature, the monoplane carries all its fuel in fiberglass wing tip tanks. Its battery access and oil filler access are at chest level with fast action fasteners requiring only thumb pressure to release. The Queen Bee's all-fiberglass 2-piece engine cowling, is easily raised, can be fully removed. Fiberglass is also used for the tail tips, the canopy, the back-lighted instrument panel, tail cone, and several interior appointments. Craft has a wingspan of 32 ft; a length of 21 ft-10 in.; has a max cruise range of 6000 mi; max speed of 150 mph; a fuel capacity of 40 gal; and a gross weight (with 4 passengers, bagage and fuel) of 2300 lb. Powered by a 180-hp engine, the craft is equipped with electrically-retractable tricycle gear and electric wing flaps.

ances in conventional measurements unheard of only a few years ago.

Major 10 areas of measurement according to the survey are: dimensional; optical; temperature and humidity; shock, vibration, and force; microwave; radio frequency; electrical (ac, dc, audio and video); pressure, vacuum, and flow; infrared; and radiological.

Where the majority of precision measurements 10 years ago concerned only the dimensions of objects, today 85% of precision measurements involve electronic or electrical quantities. Many of these newer quantities still lack adequate national standards.

INDUSTRIES REPRESENTED

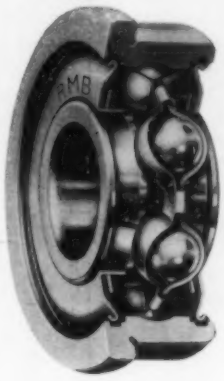
Currently, the problem is of concern primarily in the most advanced fields of technology, which includes radar, missiles, computers, navigation systems, and communications. But it is not limited to the large companies in these fields. "The vital role of small business must not be overlooked in our push to ease this critical problem," said Dr Carl A. Frische, president of Sperry Gyroscope Co. "Whether a missile will hit or miss its target may depend on the quality and accuracy of components produced by highly specialized small firms that stand right beside some of the nation's largest corporations as the very first ones to feel the 'measurement pinch'," Dr. Frische concluded. ■

Diesel-powered Ships Switching to Gas Fuel

VIENNA, AUSTRIA—Tests conducted by a team of Russian engineers are leading to the conversion of diesel-powered ships to liquified gas systems. According to reports reaching here, the switch is both possible and economical.

Only minor changes of the diesel engine are necessary. For example, the intake valve is replaced by a gas-mixing valve. The gas system consists of a vaporizer for the gas, a reduction gear train to decrease gas pressure, and steel bottles for gas storage.

The Soviet's entire Caspian Sea fleet is to be changed over by 1965. Part of the reported economy may come from using the extensive natural gas deposits at Azerbaijan, near the Caspian. Annual savings are quoted at $1,375,000 plus tens of thousands of metric tons of diesel fuel. ■



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Fuel Cell Licensing Under Sharp Attack

LONDON—Britain's National Research and Development Corp demonstrated the Bacon hydrogen-oxygen fuel cell amid sharp questioning on why future development of the British invention was likely to be in the US. The demonstration was staged by Marshall of Cambridge Electronics Ltd, which is working on the electricity-producing cell under a $224,000, two-year contract for NRDC.

The cell, which uses hydrogen and oxygen to produce electricity, measures 30 by 15 by 12 in. and has a 5 kw output. But the control equipment—governing feed of the hydrogen and oxygen and removal of waste heat—is big enough to fill the rear of a large truck. Demonstrators said reduction of control equipment bulk was the major problem being worked on.

The deputy managing director of NRDC defended licensing the cell to Patterson-Moos Div of Universal Winding Co by saying there would be more money spent in the US than in Britain on cell development "in the immediate future" and the benefits will flow back to Britain. Besides, UK industry has so far shown little interest in fuel cells.

In a separate announcement, the Ministry of Power reported work on a different type of fuel cell which would use a wide range of industrial fuel gases and distillate gases. Current work uses hydrocarbon vapor and air with a molten electrolyte supported in a sheet of magnesia. This work is being carried out at Sondes Place Research Institute. ■

NBS Extends Calibration Service

WASHINGTON—A vibration-pickup calibration service has been established at the National Bureau of Standards. An electrodynamic vibration standard was modified so that it is free of transverse motion over most of its frequency range. The standard calibrates pickups from 10 to 2000 cps at accelerations up to 10 g.

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pickups may be compared. These calibrated pickups can in turn be used to standardize pickups that are needed to test missiles, rockets, aircraft and other structures.

Errors in motion applied to pickups do not exceed 1% up to 900 cps and 2% between 900 and 2000 cps. Pickups are calibrated at three different accelerations at 10 different frequencies, for a total of 30 points. Dynamic calibrations are also made at frequencies from 10 to 15 cps at double-displacement amplitudes up to 0.5 in. ■

OEEC Fellows Study Engineering Abroad

PARIS—First grants under the Organization for European Economic Cooperation's senior visiting fellowship program have been awarded to 25 top-ranking scientists and engineers from France, Luxembourg and Switzerland. The fellows, specialists in disciplines ranging from hydro-biology to applied metallurgy, will study at advanced research and teaching institutes in five European countries and the US. US institutions participating in the program include the National Bureau of Standards, MIT, Univ of Texas, Univ of Wisconsin, Penn State Univ and Princeton.

The program to send senior scientists to study outside their own countries was set up by OEEC's Office of Scientific and Technical Personnel. Purpose is to help European training and research institutes keep on top of fast-moving developments in science and technology. OEEC has budgeted about $160,000 a year for the program, which will run several years. (For a Soviet-US exchange see PE—Aug. 17, p 23.) ■

Locomotive Runs on Either AC or DC

TOKYO—An electric locomotive that can operate on either ac or dc made its initial run this week on tracks of the Japanese National Railroad. Built for $200,000, the 1400-kw locomotive will go into service between Tokyo and Sendai, 250 mi apart. Purpose: along the line is a terrestrial magnetism research plant where alternating current must be used so as not to jam magnetic research of the earth; rest of the line is operated on 1500-v direct current. ■

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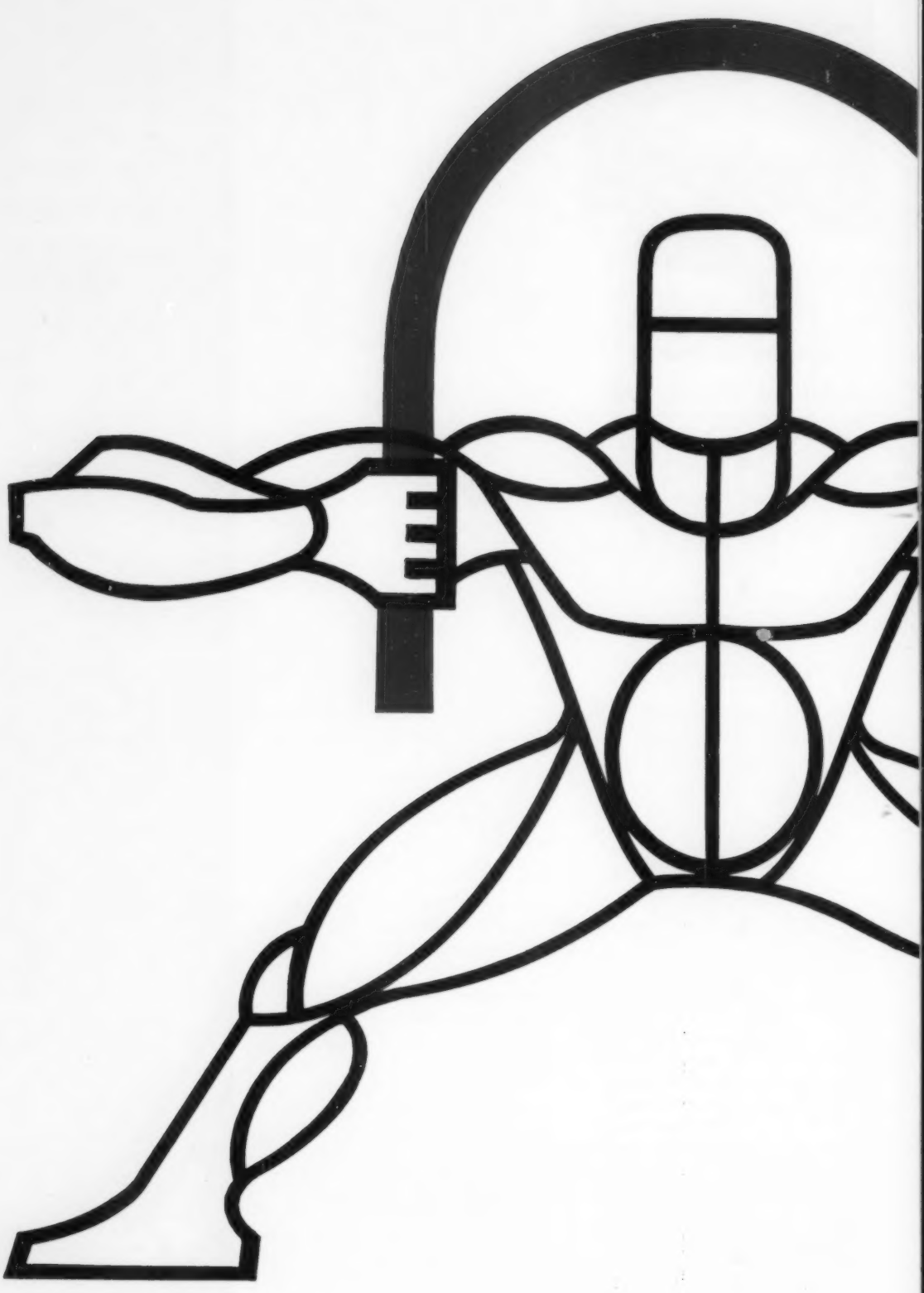

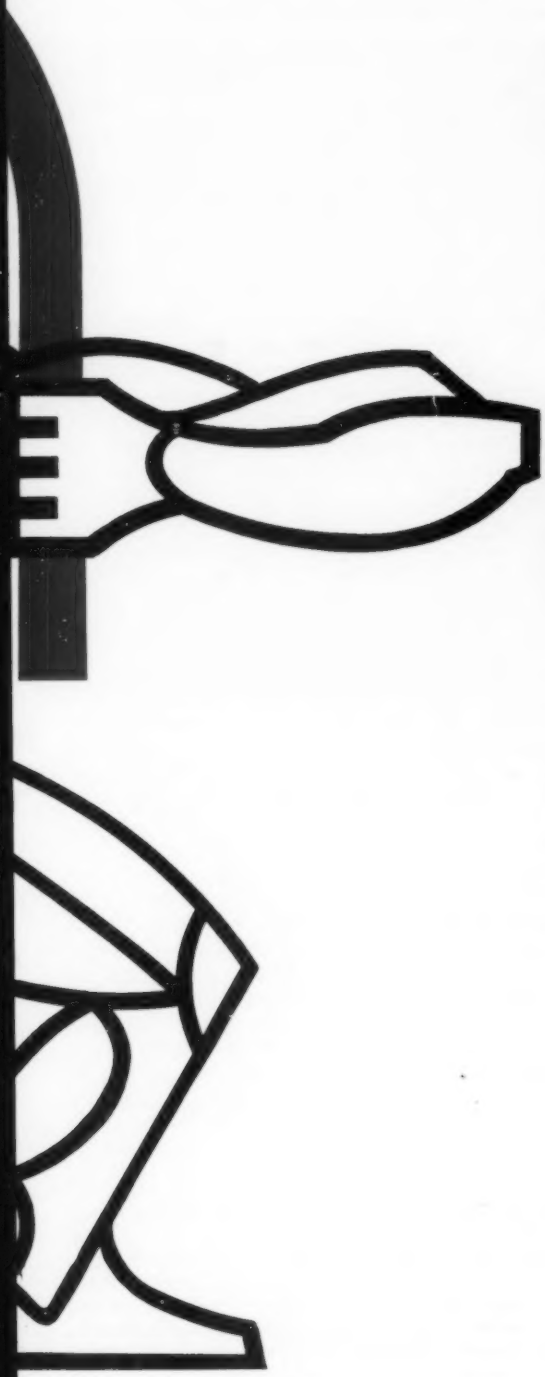

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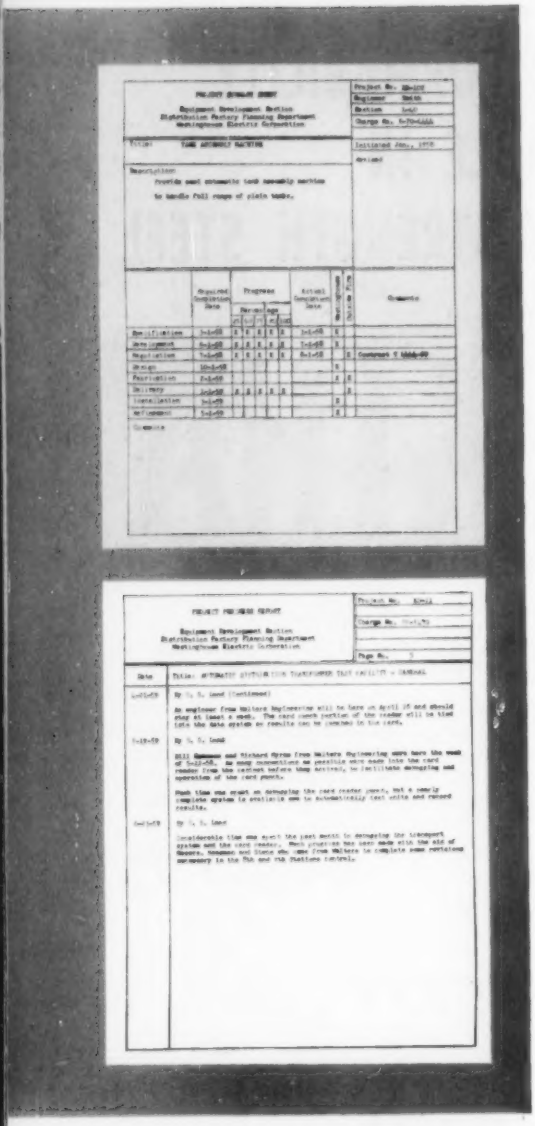
. . . *in an engineering department*

Engineering projects often move ahead in complex fashion—difficult to measure and to track regardless of the methods used. Here is a system that maintains firm control without generating undue paperwork, or stifling initiative.



JAMES J LAHM, *Supervisor*
Equipment Development Sec., Factory Planning Dept.
Westinghouse Electric Corp

■ The Russian state newspaper *Izvestia* recently brought to light the embarrassing case of a Russian scientist who spent five years as a member of their Machine-building Institute without reportable achievement or progress (*PE—July 6, p. 40*). This is encouraging news indeed—not because it shows a weakness of Moscow's system, but because it indicates we and the Russians have a common problem.

How do you control creative work when the only evidence of progress is an idea, a scrap of paper, a series of test results? How can you schedule a project when no one knows how many materials or designs will have to be tested before a satisfactory solution is found? A scheduling method that fails to keep a reasonably tight rein invites inefficiency; but if too tight, it destroys ambition and breeds employe dissatisfaction.

Schedule sets the pace

A schedule is valuable for several reasons. First, it establishes a goal. It is well-known that we make faster progress when we're working toward a goal. Even though not always met, it does provide incentive.

A schedule also helps coordinate engineering effort. It assures a reasonably even flow of work to draftsmen, modelmakers, and technicians. Such planning also makes it possible to handle several phases of a project in parallel rather than in series, thus telescoping time required for completion (see "How You Can Buy Time," Apr. 7, '58, p. 32). Another value of scheduling is that it ties the various activities of a group together. There is an added incentive to meet a date if someone else is waiting to continue the work.

But in considering the control of engineering projects we must not lose sight of the principal element: the engineer. In general, he is allergic to paper-work and report writing. Although record keeping is important, the tail must not wag the dog: an efficient control system will provide a permanent record of the projects without placing too much burden on engineers and supervision.

There are undoubtedly many arrangements which will meet these specifications. There are many more which meet only part of them. The following system has proven both satisfactory and flexible.

CONTINUED ON PAGE 34

Two Report Forms Show Project Status

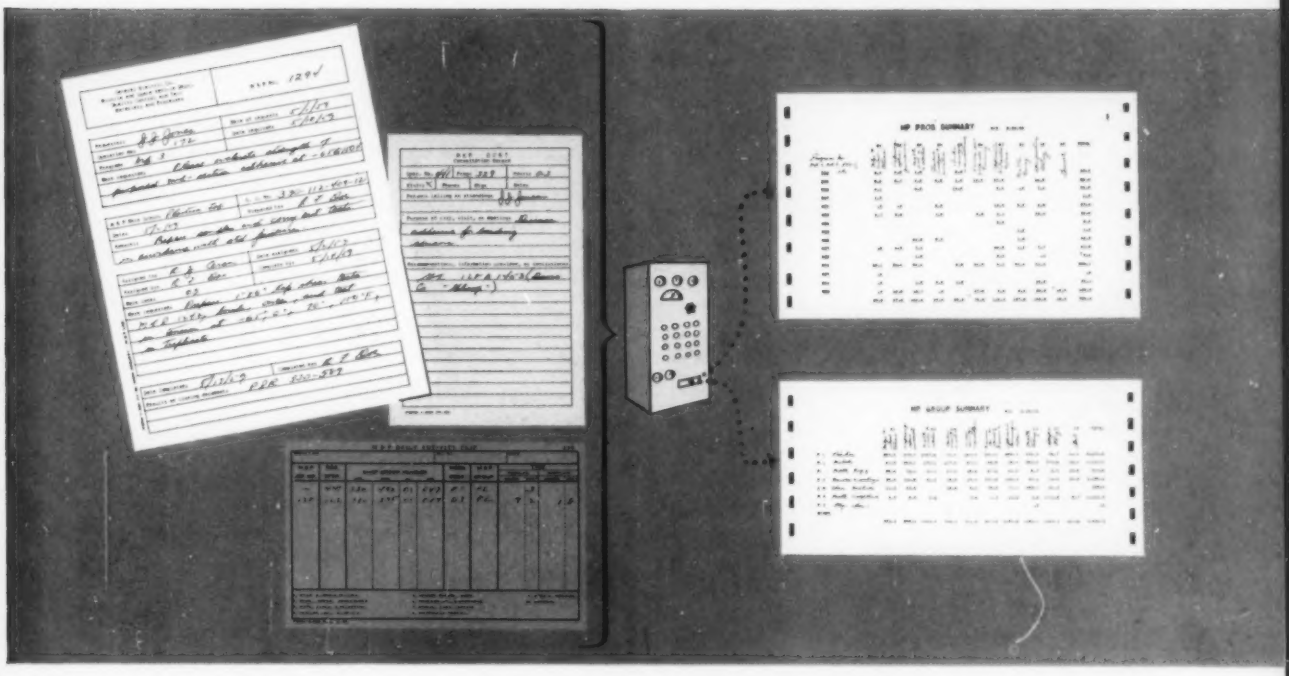
top . . . Progress Summary Sheet gives budgeted completion date for each phase of the project and estimates percent of each phase completed to date. There is also space for specific comments: on each phase and on the project as a whole.

lower . . . Project Progress Report gives detailed information. This short summary includes names, dates, problems and their solutions; also serves as reference to all letters and conference reports of importance to the project. When no work is done, the reason is stated. Both reports show the project and project number; the summary sheet includes a short description of project goals. In preparing reports, information is typed on specially prepared vellum forms and duplicated by conventional diazo processes. These are brought up to date, published and distributed once each month.

PROGRESS TO MEASURE PROGRE

. . . *in a service group*

Management needs up-to-the-minute information. To get it, this Materials and Processes group put a data-processing machine on the job.



Daily activity records . . .
are processed quickly on automatic data processing equipment to give weekly summaries. The summary sheets (right) help management measure progress and forecast future workloads.

ROBERT F KOENIG *manager,*
Materials and Processes Engineering, Missile and Space Vehicle Dept.
General Electric Co

■ Managing a research group, which deals in advice, rather than hard goods, brings up special administrative problems. Because output of such a technical staff can't be measured in conventional quantitative terms, it is difficult to set goals. Moreover, without tangible evidence of the group's contribution to the over-all business, upper management is not easily convinced that it is getting its money's worth. This makes the research budget a convenient target for cutbacks when business goes into a slump.

It is the job of the group manager to work constantly toward a solution to this problem. With the Materials and Processes Group described here, the problem was solved by developing a system which gives both comprehensive and detailed information about the day-to-day activities of the group. This has two advantages: it gives a quantitative measure of the output of the group; it helps the manager perform his normal administrative duties more effectively. To get the necessary speed, information concerning daily activities is punched into machine cards and processed by automatic accounting machinery.

Manager's responsibilities

If a control system is to be effective it must complement and reinforce the normal managerial functions. In generally-accepted terms, these are:

- Planning. This involves both short-term planning for the day-to-day problems as well as long-range thinking to assure continued growth and progress. A manager without plans is soon a manager without a job.
- Organizing. Personnel and facilities must be arranged so they are flexible—quickly adapted to changing products, staff realignments, rearrangements in procedure.
- Integrating. The work of one engineering sub-group should be coordinated with each of the other sub-groups within the major divisions as well as with other major divisions. Integration in a large organization is never accomplished; it's just something you keep working at.
- Measuring. The manager must assess the contribution of his group and the individual within it. The competition for good people is keen; to assure survival, regular

CONTINUED ON PAGE 34

TO MEASURE PROGRESS . . .

. . . *in an engineering department*

Projects to which it has been applied have ranged from simple equipment components to extremely complex systems.

The elements of control

As in most engineering organizations, every project is identified by a project number. All material and information including reports, requisitions, contracts, engineering drawings, correspondence is identified this way.

It is convenient to assign a "miscellaneous" project number to each engineer. This is for work which is significant but not extensive enough to be considered a full-fledged project. It is surprising to see how much time is spent on consultation and "unforeseen" jobs.

The paperwork for the system is not involved; it consists of only four forms. The **Project Summary Sheet** gives past history, current progress, and future requirements. The **Project Progress Report,** a familiar device to most engineers, shows, in this form, a continuous story of the project; each entry follows the previous one.

Supplementing these reports are two other forms: **Project List** and **Project Assignments.** The first is merely an index listing the number, title, initiating date, closing date of each project. This serves as a reference when only project number or project title is known. The second, issued periodically with the reports, lists each engineer and the project for which he is responsible. It also shows projects which have been transferred, or closed during the month.

The system in operation

Each engineer is required to make progress reports each month. As soon as possible after the reporting date, the supervisor reviews each project with each engineer in as much detail as is necessary. Project progress, drafting and technician requirements, financial status, and any other pertinent matters are discussed at these reviews. It is during these reviews that the **Project Summary Sheets** and **Progress Reports** are revised and brought up-to-date.

All the necessary paperwork can generally be typed and duplicated within a week of reporting date. The **Project List,** however, should be revised only as necessary, probably on a quarter-annual basis.

Distribution of this information is a matter of policy. In general, however, **Project Progress Reports** are either routed, or a copy sent to the various parties concerned. If, for example, a new machine is being developed, the foreman, project engineer, methods engineer, and several others will get reports. Although not immediately concerned, they may be planning or know something which would conflict with the objectives of the project. Second-level supervision is generally interested in the **Project Summary Sheet.** This provides a capsule of information which can be digested at a glance.

There are many advantages to this system. First, it is inexpensive, not only in terms of the forms and clerical time required but in terms of engineering and supervisory time as well. The main burden can be handled by a stenographer. Moreover, the supervisor is reminded to review dormant projects at least once a month. This keeps him in touch with the status of his work. ■

. . . *in a service group*

appraisals of individual performance and an adequate salary program are essential.

A review of these primary responsibilities and a study of the types of work performed by the group in solving a typical technical problem—planning, ordering, testing, analyzing, reporting,—led to the following system.

Step one: Information gathering

Two general classes of work were established: consultations, and all others. Consultation involves answering phone calls for information, attending meetings as a consultant, and providing technical information where no laboratory work or written request is required. These are recorded on a consultation slip. All other types of work are initiated by a standard work-request form which also serves as the record.

The consultation slips and work requests both indicate information such as the type of work, time spent, group being serviced, and project number. At the end of each day, each engineer summarizes consultations and other types of work on his activity slip. Type of work is indicated by a code number.

Step two: Information processing

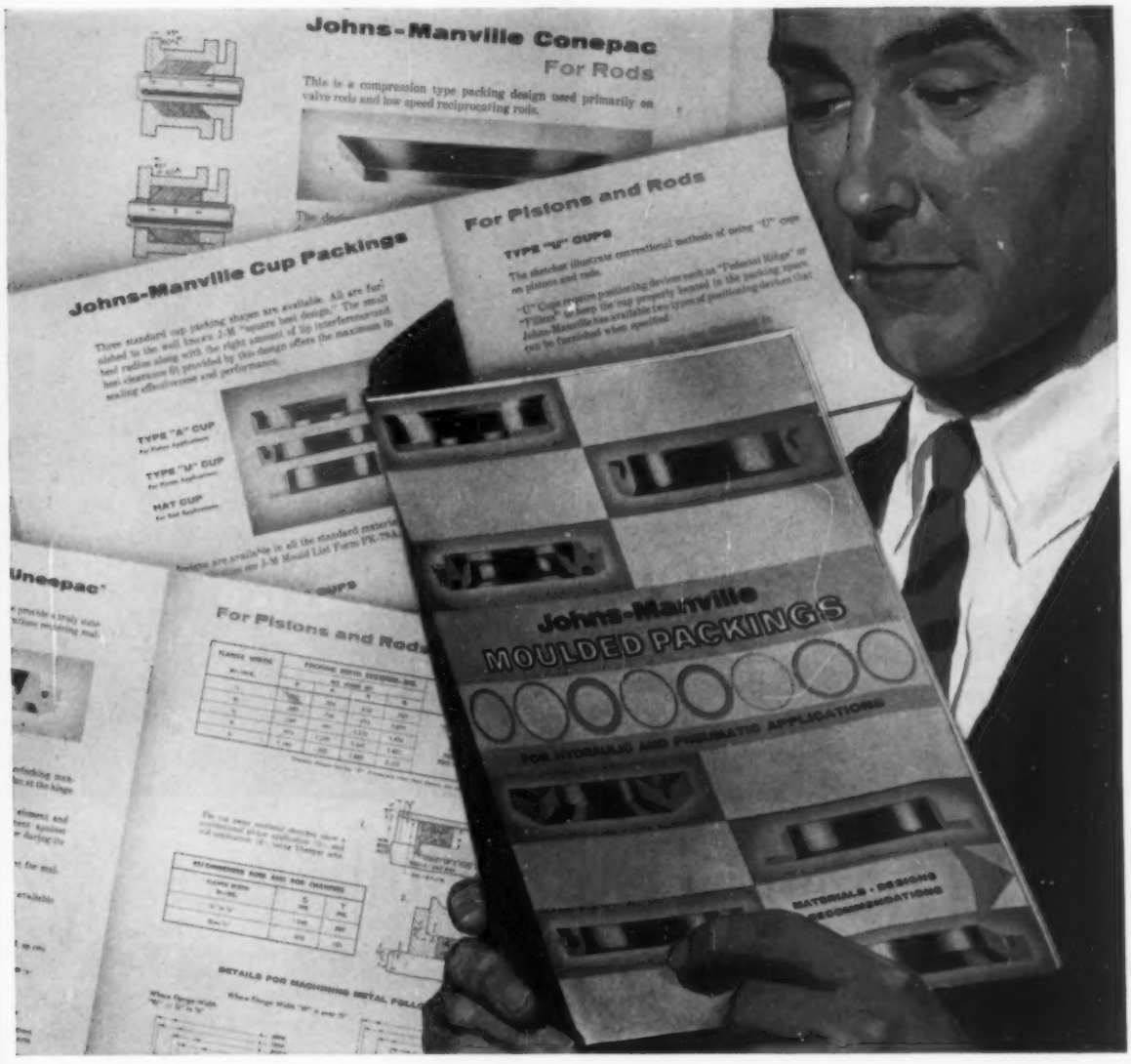
Information on the activity slip is punched into business machine cards. These are processed each week. The types of work and hours spent are compiled several ways. One sheet is arranged by project number; another is arranged to show the engineering department that was served.

Most valuable reports are these weekly and quarterly summaries of the work done for each engineering department serviced. In planning for future work and in carrying out budget exercises, they have been more useful than any other information available. They also tell managers of the departments how much work is done for them and the extent to which their people use the services of the Materials and Processes group.

In addition to the daily activity slip, each engineer submits a brief weekly report which shows total number of consultations, number of technical documents issued, and estimated backlog of work in man-days for all programs. A report which compares present status with scheduled status is also submitted each week and returned after review. In addition to their value to management, these weekly reports allow the engineer to measure his progress and improvement.

Week-to-week variations in all these data are large and not especially significant; consequently, the data are accumulated for each quarter and then plotted. The graphs provide a measure of group activity and form the basis for predicting personnel and facility requirements. They can also be correlated with number of products-shipped to indicate how this is related to the activity of Materials and Processes group.

This program has not been static; changes are made whenever areas for significant improvement appear. But the system fulfills the basic requirement which led to its establishment: it provides information for planning, organizing, integrating, and measuring a technical support service in a large R & D organization. ■



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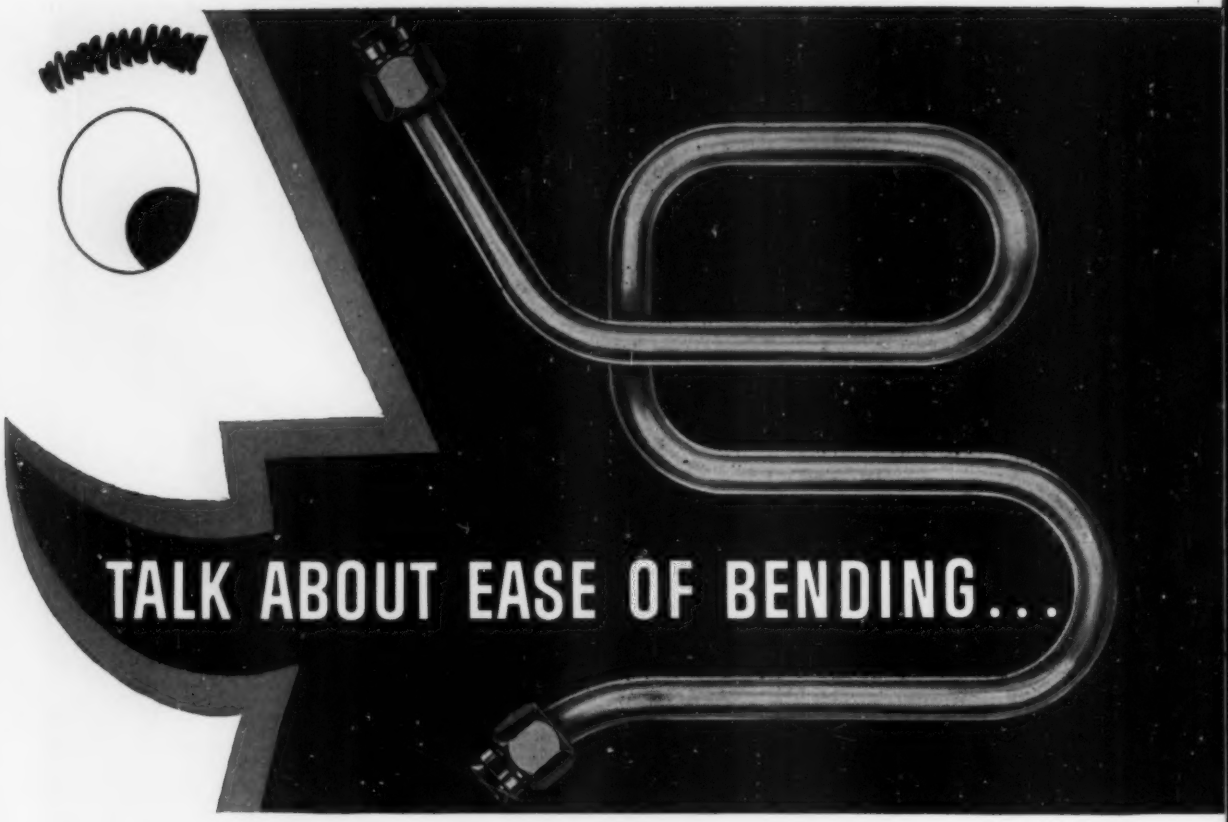

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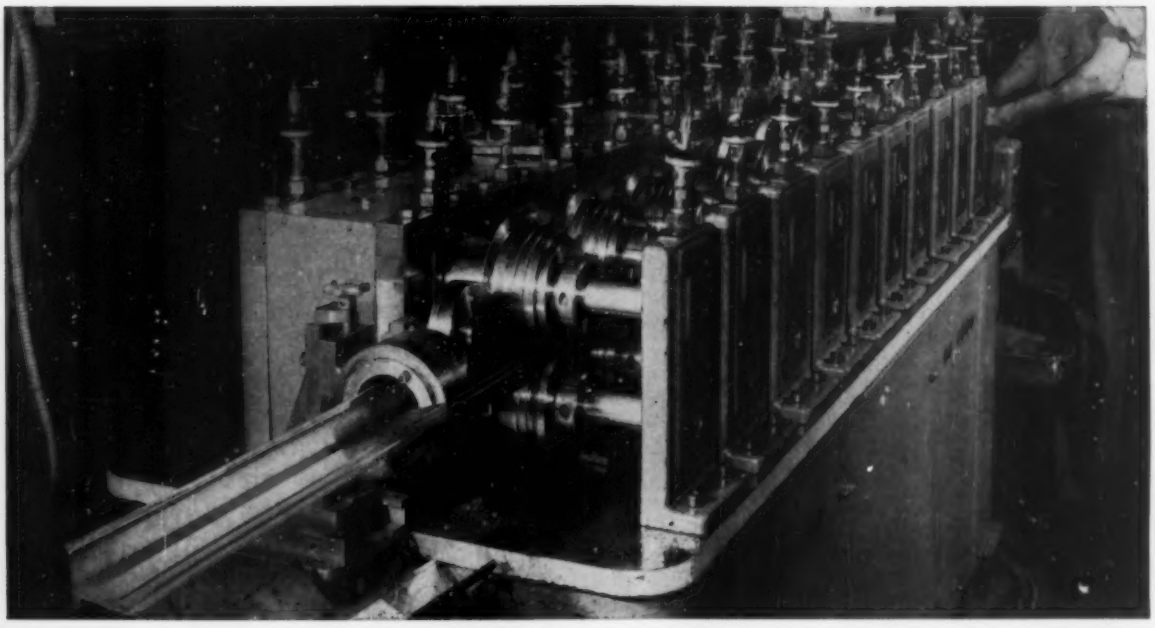

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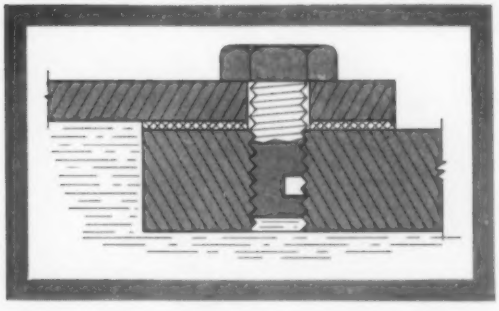

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- ☐ Republic ELECTRO PAINTLOK

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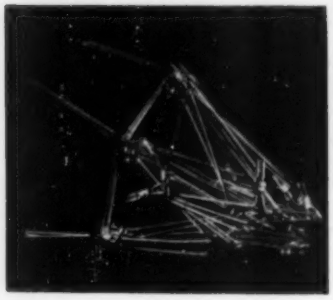
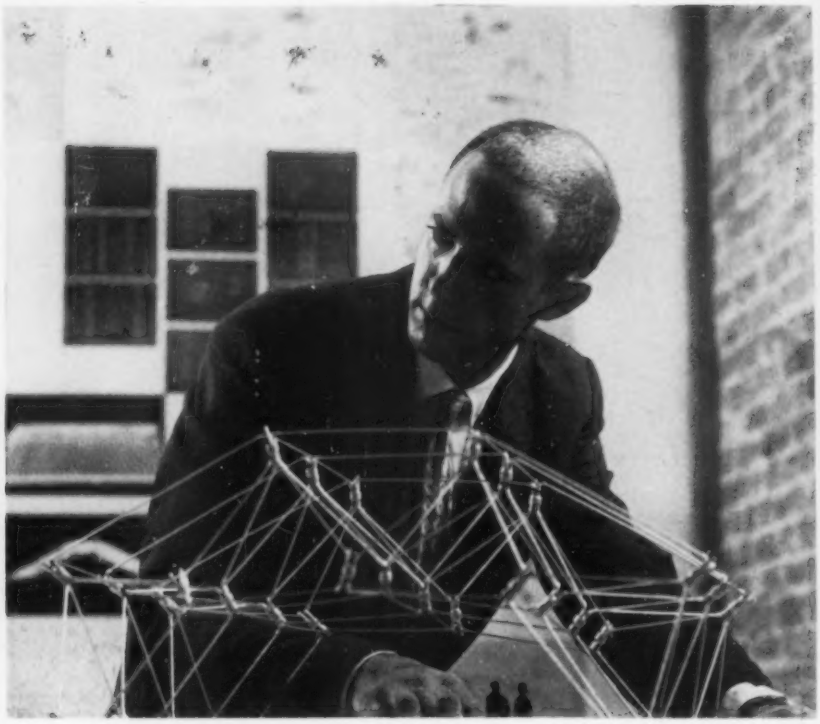
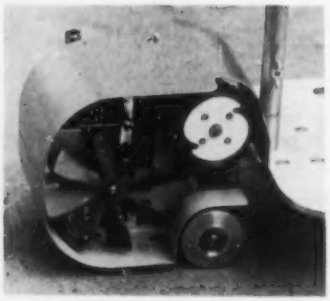
Expandable and portable dome structure can be used to support tent over anything from an exhibit area to athletic playing field. Designed by Herbick Van Reisgen of Philadelphia Museum College of Art to be made of tubular elements, fastened at each end to a universal joint, joining four such tubular members. Motorized control of expansion and contraction is proposed. Dome is shown below, folded for transportation by truck.







Powered by an 0.6 cu in. displacement model airplane engine, this scooter runs about 20 min on 3 oz of gas, and attains top speed of 20 mph. Rider starts engine, gives slight push to gain headway and steers by leaning in desired direction. Can make complete circle 4 ft in dia. Designed by Louis Richards, left, of Illinois Institute of Technology, and proposed for use by mailmen, sight-seers, factory and office messengers.

student awards

Five industrial design students have been named for Merit Awards by Aluminum Co of America. The competition was one of a series of coordinated activities with industrial design schools, and entailed the development by students of product designs entailing the use of aluminum products. Awards were made to students chosen by their own faculties in each case, on an evaluation basis determined by the schools themselves.

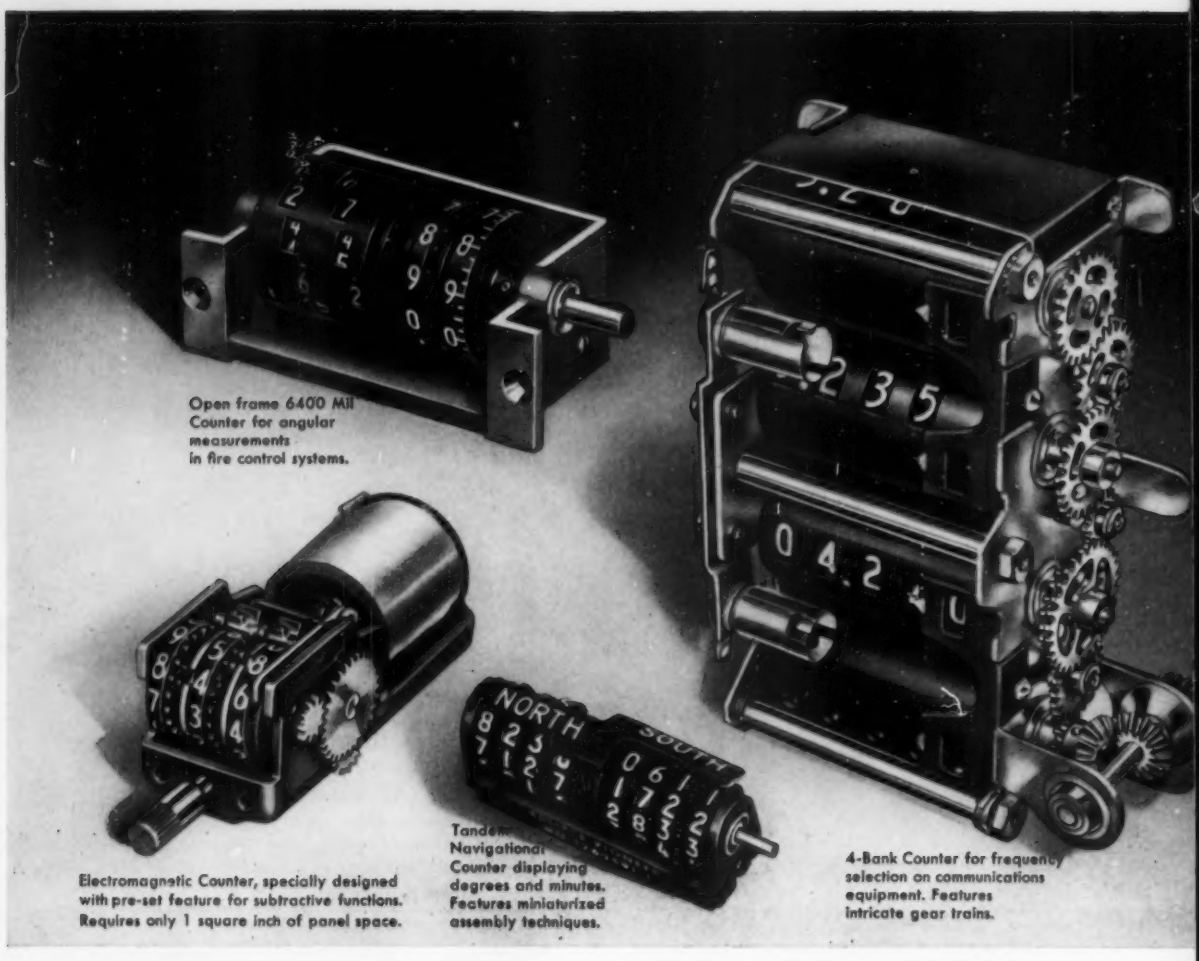
The five winners, their schools, and their designs are:

Arthur Goodbread, Syracuse University, gumball machine.
Samuel Leibowitz, Pratt Institute, egg storage and dispensing system.
Louis Richards, Illinois Institute of Technology, power scooter
William E. Stumpf, University of Illinois, movable modular home.
Herbick Van Reisgen, Philadelphia Museum School of Art, adjustable dome structure.

Inserting penny and moving handle causes gumball dispenser's pinwheel to spin, its top to rise and fall, and a gumball to drop down through chute between legs. Arthur Goodbread, Syracuse University, is shown adjusting his machine.

Entire 10-ft-square room of movable, modular house is delivered direct from factory to site as a unit, as designed by William E. Stumpf, University of Illinois. Room units may be joined to any side or to top of any other unit. Stilt-like jacks adjust to variations in terrain.

Hen's eggs are dispensed from heat-sealed aluminum foil strip pouches by machine that automatically places them on griddle or in mixing bowl. Foil strip is moved along traveling rack by sprocket holes punched in its edges. Designed by Samuel Leibowitz of Pratt Institute for use in institutions, restaurants, the armed services.


Open frame 6400 Mil Counter for angular measurements in fire control systems.
Electromagnetic Counter, specially designed with pre-set feature for subtractive functions. Requires only 1 square inch of panel space.
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The Veeder-Root Counters shown here are only a small selection of the specialized line of precision counters developed for instrument and military applications. Each demonstrates Veeder-Root's ability to design and produce to high precision, fine tolerances, and military specifications, and to satisfy severe environmental testing requirements.

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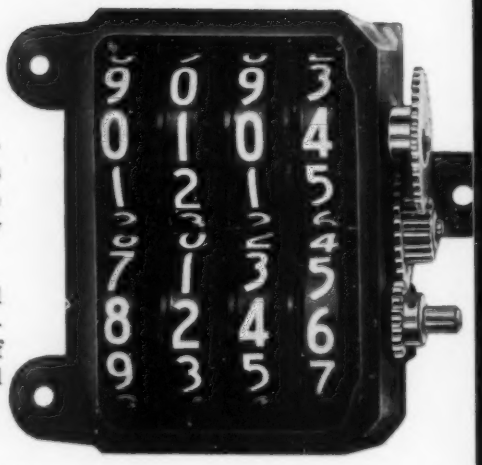

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POINTS OF

THE QUESTION: ***"Are Printed Circuits Oversold?"***

"No . . .

Printed circuits as used by the majority of the consumers' products industry represent a distinct advance in the production of electronic products. First, better performance is achieved. The increased uniformity of circuit layout, coupled with its permanence, results in circuits better optimized by the design engineer over hand-wired layouts with their dependence on operators.

"Second, their more efficient production is readily apparent, and this increases with the compactness of the device. Printed circuits lend themselves to automation to a far greater degree than hand-wired chasses. Third, increased reliability results from the improved uniformity and permanence. Printed circuits lend themselves to excellent humidity protection. This increased reliability is true not only in production, but the serviceman has increased security in knowing that a replacement is properly located and critical leads connecting it into the circuit are not disturbed by the replacement.

"Fourth, printed circuits add to serviceability. They are easier to service than hand-wired chassis. The circuit is easily traced and in many cases the actual circuit is printed on top of the board with parts symbols added. The fixed location of parts and their leads eliminates guess work."

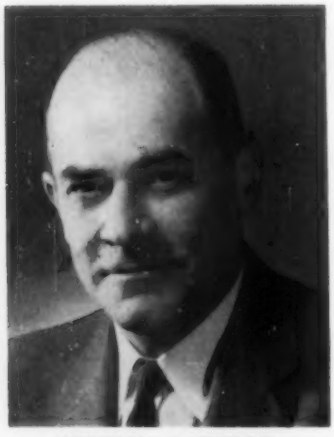
PALMER M CRAIG
VP, Engineering
Electronics Operations
Philco Corp

"No . . .

I do not believe that printed circuits have been oversold. Any feeling of overselling may have been generated by the misapplication of printed circuits or poor adaptation of the techniques to specific devices. Printed circuits have and still are providing the electronics industry and their customers with many plus features. There is no question that they have provided cost reductions. In military electronic equipment they have provided improved performance under severe environmental conditions in the form of less maintenance, with higher reliability.

"In manufacturing, printed circuits allow a quality control of wiring for superior circuit performance not obtainable in any other way. Printed circuits are easily adapted to automatic assembly of components, automatic soldering and automatic testing of a complete circuit function. These, of course, are highly desirable features in any large quantity production of electronic circuitry. Even on low-quantity production with manual assembly of the components and manual soldering we retain the plus features of quality control and reliability.

"Printed circuits in most of the present-day forms are a natural evolution from the unitized plug-in assemblies of components which were wired with numerous parallel bus wires. The present concepts of printed circuits lend themselves to further evolution in future electronic equipment. I do not want to leave the impression that all electronic circuitry will be of the printed type. There are many applications where conventional or unique circuit techniques will continue to be required."



EDWARD F HERZOG
Manager—Engineering
Heavy Military Electronics Dept
General Electric Co

"It depends on the application . . .

Certainly for many present applications their use is unjustified. Large radio receivers and television sets are an example. Generally speaking, one should not use a new process or technique where the cost of additional raw materials is greater than the whole cost of the process it surplants. My experience with radio, which goes back to 1921, is that wiring is almost always a trivial part of the cost of electronic equipment and that the industry so far has not stood still long enough to justify large outlays for automatic machinery, except for its basic components. The thing that has made electronics wonderful is that one only needs a soldering iron to build anything from a crystal set to a digital computer. I would hate to see this great flexibility of electronics disappear.

"Printed-circuit wiring occupies more space than conventional wiring and, contrary to popular belief, printed circuits do not produce smaller packages than can be produced without them. Unless very high quality materials are used, such as glass epoxy mixtures, insulation problems are severe, particularly because leads are usually longer than with conventional wiring. Two-dimensional wiring also produces some topographical difficulties not otherwise present. Mechanized wiring, in general, makes changes difficult and expensive and should be employed only for very large scale production.

"Where printed circuits do shine are in fields where, in addition to the automatic wiring, one needs electromechanical elements such as commutators, switches, coils and other circuit components. Here the shape and size of the conductors are, in themselves, important. In miniature low-voltage assemblies, printed circuits become more than competitive with hand wiring and are fully justified. In plug-in assemblies, such as in computers, where appearance and convenience are of greater importance than cost, printed circuits are fine. Finally, there can be no argument that printed circuits can be made visually beautiful and that if beauty is desirable one should expect to pay for it."

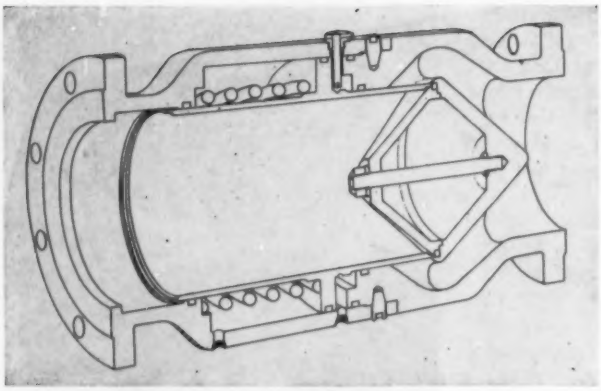
J RABINOW
President
Rabinow Engineering Co Inc
Washington, DC

RICHARD B LENG
Vice President
Technical Products Div
Packard Bell Electronics Corp
Los Angeles, Calif

"That's like asking a man . . .

if he beats his wife. It would be difficult to admit, even if it were true. I believe it is impossible to over-emphasize the impact of printed boards upon the electronics industry—and equally impossible to oversell their importance. The trend toward ever increasing reliability, miniaturization and modularization in today's advanced electronics systems make the printed circuit a really necessary building block. Of course, the high quality printed circuits necessary for military products are currently too expensive for commercial use. In time more economical boards will be developed and, contrary to opinion in some quarters, I believe they will be a help rather than a hindrance to commercial field service, because they will be designed with service in mind."

SIGNIFICANT COMPONENTS & MATERIALS



Sliding-sleeve control valve . . .
with response time of 3/1000 sec has diameter no larger than pipe or piston on which it is mounted. There is no stem-and-wheel branching up from tubular valve. Mouth diameter can be designed from ½ to 36 in. or more. Hydraulic valves, in several models, are rated for pressures up to 12,000 psi and can be remotely actuated by electrical, electronic, hydraulic or pneumatic controls. Model 4110 (illustrated) is an automatic, remote-controlled valve that will regulate up to 200 psi line pressure with 15 psi instrument air. As shown, valve will close if instrument air pressure fails. By reversing sleeve-like piston and spring, valve can be made to open wide if air pressure fails. By addition of auxiliary device, valve may be made to sense line pressure and close (or open) at predetermined pressure or change in pressure. Indicator shows valve position. Suitable for water, oil, motor fuels, air, sea water and chemicals. Operating temperature is limited only by composition of O-ring seals. **Bendix-Pacific, Div of Bendix Aviation Corp, 11600 Sherman Way, North Hollywood, Calif.**

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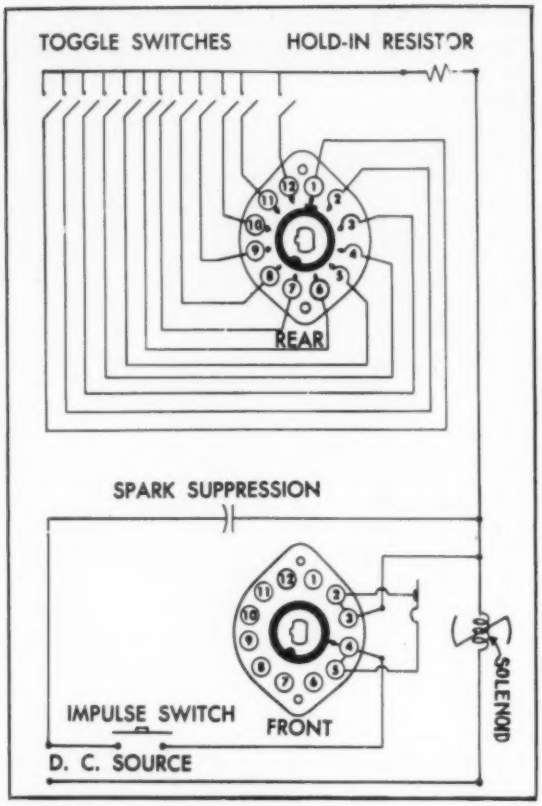
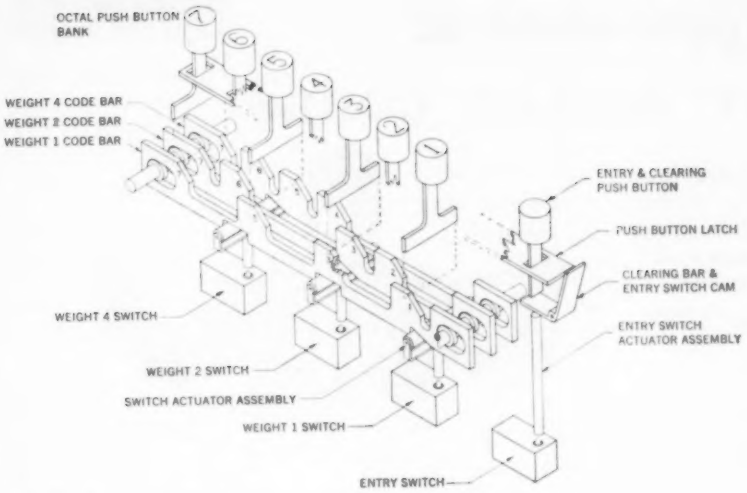
for use in infrared optical systems are said to reduce thermal expansion characteristic of glass mirrors now in use. Material consists of fine grade, sturdy, light-weight porcelain. Ceramic base, of alumina and silica clays, forms dense, nonporous substance that can be finished to optical quality. After formation and finishing, base is coated with aluminum. Ceramic mirror blanks can be ground and polished using standard optical techniques. **Ramo-Wooldridge Div, Thompson Ramo Wooldridge Inc, PO Box 90534 Airport Sta, Los Angeles 45.**

Circle 102, Reader Service Card



Variable programming circuit . . .
employs rotary selector to control and change sequence of functions in automatic equipment. Selector uses inverse-homing, tab-type, control-wafer switch, in conjunction with hold-in resistor. When impulsed, causes selector to skip unwanted positions. Variations in positioning of selector are accomplished by placing toggle switch between hold-in resistor and each homing contact. Open toggle switch permits selector to step past that position automatically when impulse switch is closed. This occurs because solenoid is energized only through interrupter switch. If toggle switch is closed, resistor will be placed in parallel with interrupter switch; when interrupter switch is opened, hold-in resistor is placed in series with coil. Solenoid, therefore, remains energized at position until impulse switch is released. Available for any dc voltage between 6 and 350 v. Price is dependent upon operating voltage and number of circuit wafers used. Utilizing selector with four circuit wafers, price would be about $10 each, in quantity. Delivery on standard units, 4 to 5 wk. **G H Leland Inc, 123 Webster St, Dayton 2, Ohio.**

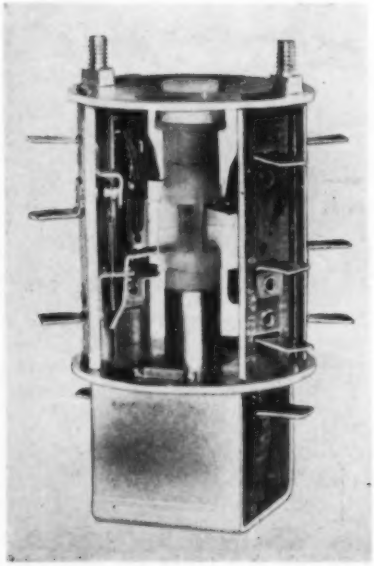
Circle 103, Reader Service Card



Code bar converter . . .

translates octal or decimal input into binary digits by cam-type code bars, without resorting to multiple-relay contact arrangements. Binary coded outputs are in the form of contact closures with double-throw contact arrangements. Mechanical interlock permits only one pushbutton key to be depressed at a time, automatically releasing any previously depressed button. Over-all switch dimensions (7x3¼x⅝ in.) permit stacking to form complete keyboards. Price for 1 to 9 units of OS-1, $53 each; for OS-2 and DS-1 models, $58 each. **Computer Control Co, Western Div, 2251 Barry Ave, Los Angeles 64.**

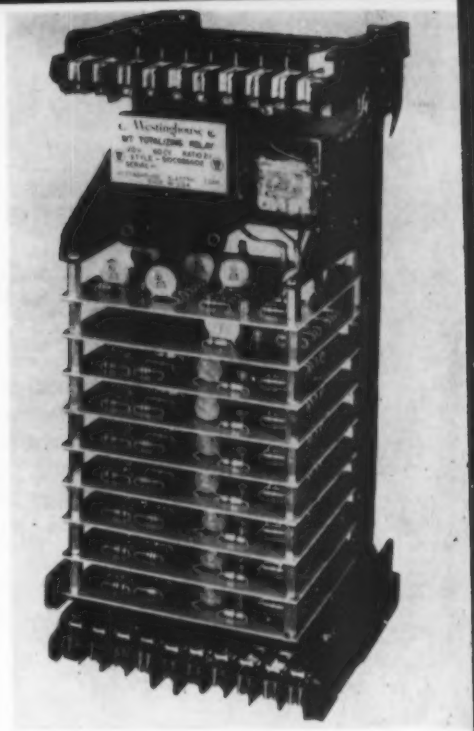
Circle 104, Reader Service Card



Solenoid-operated relay . . .

with snap-action is said to be particularly well suited to control of several circuits handling inductive loads. Available in contact arrangements up to 6PDT. Each snap-action contact is rated 10 amp, ½ hp, at 125 v ac or 5 amp, ½ hp, at 250 v ac. Spacings and insulation meet UL requirements. Plunger clears top of frame for pushbutton, self-holding operation, where desired. Will operate in any position. Over-all dimensions are 3¼ in. long x 1⅞ in. dia. Prices, depending upon number of poles (1 to 6) and quantity, range from $5.44 to $8.68 each (for 10 to 49 units) and $2.34 to $4.15 each (for 10,000 or more). Up to about 250, immediate delivery; larger orders, about 5 wk. **Warco Industries Inc, 6625 Delmar, St Louis 30.**

Circle 105, Reader Service Card



Impulse totalizing relays . . .

use semiconductor devices to combine demand impulses from as many as seven sources in multiunit metering systems and retransmit them over single output circuit. Except for one output relay, all circuit elements are conservatively-rated static devices, such as transistors, silicon diodes, condensors and resistors. Max output rate is 450 impulses per min. Max input rate depends on number of input channels to be totaled. 3-channel relay is rated 600 impulses per min. per channel. All three units are available in output-impulse to input-impulse ratios of 1:1, 2:1 or 4:1. Input impulses can originate from any three-wire contact device or equivalent. Mounts in standard relay case, measuring about 16 x 6 x 8 in. Priced from $940 to $1,460. 90-day delivery. **Westinghouse Electric Corp, PO Box 2099, Pittsburgh 30.**

Circle 106, Reader Service Card

Microminiature indicator lamp . . .

operates directly from output of transistor, without amplification. Operates at less than 1.5 v and draws less than 50 milliamp. Housed in vial 0.110 in. long x 0.050 in. dia with two platinum leads extending from one end. Suitable for transistor circuits, computers and electronic devices. **Minitron Components Corp, 67 Illinois Ave, Paterson, NJ.**

Circle 107, Reader Service Card

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Extra-heavy Neoprene jacket. Permanent flexing qualities. Extra thick insulation. Cord resists food chemicals, odors and may be wiped clean without damage to coil action. Available with miniature UL appliance plug, standard UL appliance plug, or tight fitting factory applied eyelets for internally wired appliances. New "snug plug" blades hold firmly in outlet.

TYPE SP

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TYPE SJ

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CORDS LIMITED

DIVISION OF ESSEX WIRE CORPORATION

DeKalb, Illinois

SIGNIFICANT COMPONENTS
MATERIALS
PROCESSES . . .

Stainless speed retarder . . .

employs power of exhaust gases to decelerate and to reduce operating and maintenance costs. Basically, retarder is butterfly valve and shaft in housing bolted directly to stainless steel manifold outlet. When actuated, retarder slows down any moving load that a powerplant can accelerate, at the same rate or faster, under the same conditions. Unit converts each powerplant cylinder into a low-pressure (40 to 50 psi) air compressor. As long as engine turns over, each cylinder continues braking action, fully or semi-automatic. Braking force is controlled by hand lever; manual cutoff is provided. Braking device is suitable for over- and off-the-road vehicles and stationary equipment powered directly by internal combustion engines. **Power Brake Equipment Co, Portland, Ore.**

Circle 108, Reader Service Card

All-purpose transistors . . .

selling for as low as 50¢ in quantity lots are said to be generally 20 to 30% lower than competitive units. Alloy junction series includes 10 types for general-purpose industrial use. **Texas Instruments Inc, 6000 Lemmon Ave, Dallas 9.**

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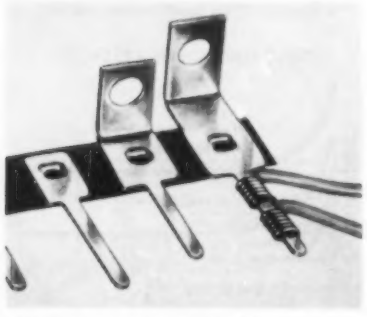


Wire wrap terminals . . .

accept one or more wire leads in each terminal and are said to speed assembly of electrical-electronic units, connectors for coil forms, printed circuit boards. Square lug prevents turning. Special plating or material can be supplied. From stock. **Malco Mfg Co, Dept PE-1, 4025 W Lake St, Chicago 24.**

Circle 110, Reader Service Card

Position transducer . . .

is cable-operated electromechanical measuring instrument that translates linear displacements, from a fraction of an inch to over 180 in. in various sizes, into proportionate dc voltage or resistance. At accelerations to 4 g, unit has accuracy of 0.1%. Weighs 2 lb. **Waldale Research Co Inc, 362 W Colorado Blvd, Pasadena, Calif.**

Circle 111, Reader Service Card

Rectilinear potentiometer . . .

series are available with single or dual elements and stroke ranging from 2½ to 10 in. ¾-in. dia. cylindrical units withstand shock, acceleration, vibration in excess of 50 g without opening or discontinuity. Independent linearity is 0.2%. **Markite Products Corp, 155 Waverly Pl, New York 14.**

Circle 112, Reader Service Card

Standard valves . . .

for 1 and 1¼ in. pipe sizes, in master, single solenoid and double solenoid body styles extend stock range to six sizes and are recommended for fast cycling of large-bore cylinders. **Galland-Henning, Nopak Div, 2753 S 31st St, Milwaukee 46.**

Circle 113, Reader Service Card

Elapsed time indicator . . .

is subminiature unit with 1.8 billion: 1 gear train, low-inertia synchronous motor and 2½ w max power input. Measures 1 $\frac{7}{16}$ in. OD x 1 $\frac{13}{16}$ in.; weighs 3 oz. Hermetically sealed. Total readout is 10,000 hr, readable to closest hour. **Waltham Precision Instrument Co, 221 Crescent St, Waltham 54, Mass.**

Circle 114, Reader Service Card

Ball-bearing slide . . .

for rack-mounted equipment is three-section unit with extended-position locking, quick-disconnect mechanism, MIL spec approval, 150-lb load rating. **Grant Pulley & Hardware Corp, High St, W Nyack, NY.**

Circle 115, Reader Service Card

Aluminum fittings . . .

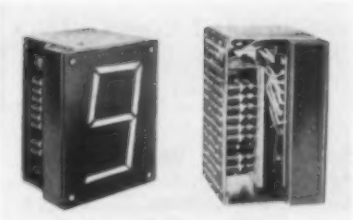
for schedules 10 and 40 pipe are now available in 3003F, 6061-T6 and 6063-T6 alloys. Serrations on ID allow either pipe or fitting to be expanded directly into union or flange. Other fittings include tees, crosses, 45 and 90° elbows, caps, eccentric and concentric reducers and stub ends. **Speedline Div, Horace T Potts Co, Erie Ave and D St., Philadelphia 34.**

Circle 116, Reader Service Card

Solenoid valve . . .

handles heavy loads despite weight, 0.21 lb. 400 cps, nonrectified ac valve handles liquids or gases. **Aero Supply Mfg Co Inc, Corry, Penna.**

Circle 117, Reader Service Card



Selective digital readout . . .

requires only 2½ in. back of panel. Displayed characters are said to be visible even with high ambient light and at viewing angles up to 150°. Switching circuit for displayed characters consists solely of resistor and capacitor matrix and neon bulbs. Multiple units may be arranged in-line, occupying 3 x 4 in. panel space per digit. Characters are 2 x 3 in. Operates on 350 v ac or dc. 11 inputs are provided; decimal point is available. Prices start at $15 in production quantities. **IDEA Inc, 7900 Pendleton Pike, Indianapolis 26.**

Circle 118, Reader Service Card

Self-aligning rod end coupler . . .

for air and hydraulic cylinders permits axial alignment between cylinder and machine. Coupler for ⅝, 1, 1⅛, 1¾ and 2 in. dia rods are from stock. Larger sizes, from 2½ to 6½ in., to order. **Hydro-Line Mfg Co, 5600 Pike Rd, Rockford, Ill.**

Circle 119, Reader Service Card

Linear potentiometer . . .

is ½-in. unit for internal installation in hydraulic actuators. Operates in temperatures of −65 to 275 F and is said to be capable of withstanding vibration to 35 g. Ranges are ⅛ to 12 in. Linearity is 0.5% of full range. Over-all length is 1⅞ in. plus travel. Meets military environmental requirements. **Servonic Instruments Inc, 640 Terminal Way, Costa Mesa, Calif.**

Circle 120, Reader Service Card

Subminiature detector . . .

capsule (0.08 in. dia x 0.5 in. long) encloses sensitive silicon light-sensing element. Generates 300 microamp min into 1,000 ohm load at illumination level of 1,250 ft-c of tungsten light at 2,800 K color temperature. Detector cell has response of less than 20 microsec. Silicon light sensing element has active area of about 0.13 x 0.05 in. Designed operating temperature is 131 F. Reverse bias is limited to −1 v and 'dark' reverse current is less than 10 microamp at reverse voltage of 1 v. Two 0.01 in. dia leads, connected with positive and negative cell contact areas, extend 1¼ in. from capsule base. **Hoffman Electronics Corp, 3761 S Hill St, Los Angeles 7.**

Circle 121, Reader Service Card

SIGNIFICANT COMPONENTS
MATERIALS
PROCESSES . . .

Subminiature valve . . .

regulates small cylinders, operating diaphragms, pilot cylinders. In 3 and 4-way versions milled from solid aluminum bar stock. Tapped for ¼ or ⅛ in. pipe connections. Rated for 0 to 125 psi for air, oil, water or high vacuum service. In six different valve actions. **Hunt Valve Co, Salem, Ohio.**

Circle 122, Reader Service Card

Butt-welded tantalum tubing

now available from stock in sizes 1 in. OD with 0.010 in. wall thickness and 1½ in. OD with 0.013 in. wall thickness. **Haynes Stellite Co, Div of Union Carbide Corp, 420 Lexington Ave, Dept TT, New York.**

Circle 123, Reader Service Card

Improved nuclear battery . . .

operation depends upon beta particles emitted by isotopes that penetrate dielectric material (glass ampoule containing Krypton gas) and collect on metal envelope. Batteries have current rating of 200 to 1,000 muamp and open circuit potential of several thousand volts. **Patterson Moos Div, Universal Winding Co, 90-28 Van Wyck Expressway, Jamaica, NY.**

Circle 124, Reader Service Card

Magnetic limit switch . . .

acts on proximity of two sensing elements. Consists of probe (mounted on stationary part of machine being controlled), magnetic trigger (on moving part of machine or on part being machined) and power amplifier. Response time is less than 1 millisec. Power input at full load is 7 w, 115 v, 60 cps ac. **Consolidated Controls Corp, Bethel, Conn.**

Circle 125, Reader Service Card

Indexing drives . . .

for speeds up to 1,000 indexes per min with output torque rating of 1100 in.-lb and up are available. Indexing accuracy is said to be held within 0.001 in. on 12-in. circle. Standard models are available with indexing periods of 270, 180 or 120° with 3, 4, 6, 8, and 12 stops, left or right-hand cams. **Commercial Cam & Machine Co, 455 N Artesian Ave, Chicago.**

Circle 126, Reader Service Card

Pressure transducers . . .

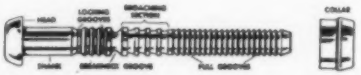
which measure full system differential pressures at each port use two half-bridge elements connected in full bridge with all active legs. Pressure ratings are 0 to 100 through 0 to 5,000 psi. Sensitivity can be from 2 milliv per v to 4 milliv per v. Temperature range is −28 to 275 F. **Standard Controls Inc, 1130 Poplar Pl, Seattle 44, Wash.**

Circle 127, Reader Service Card

Solid-state timing module . . .

has timing range of 10 millisec to 5 min., with accuracy said to be 10% of normal, repetitive accuracy better than 2%. Ac-operated from 115 v to 24 v, 50 or 60 cps. 28 v dc units from stock. Subminiature, time delay relays are for 32 to 180 F use. List price, $79. **Syracuse Electronics, Box 566, Syracuse 1, NY.**

Circle 128, Reader Service Card



Self-broaching fasteners . . .

automatically produce optimum interference-fit installation. Said to have same shear and tension values as close-tolerance fasteners made by company of equal diameter in AISI 4037 material. Same collars are used. Self-broaching fastener is available in 7/16 and ¼-in. nominal pin dia, lengths as required. Design contains progressive broach integral with fastener pin. Fastener broach is capable of removing up to 0.010 in. material on the diameter. Self-sizing fastener is similar, but has extruding land integral with pin, in place of progressive broach. With it, drilled hole is expanded to proper size. 7/16 and ¼-in sizes. Evaluation quantities of several head styles and grips from stock; production quantities, 4 to 6 wk. **Huck Mfg Co, 2480 Bellevue Ave, Detroit 7.**

Circle 129, Reader Service Card

Gear motors . . .

in ten standard single and double worm reduction models employ worm cut directly on motor shaft. Outputs range from 10 to 750 rpm. High-speed first gear is fiber; low-speed gear, bronze. Shaft position can be changed to six 30° positions. 6 x 3 7/16 x 3⅜ in. high; weight, about 5 lb. Available as universal, shunt or series motors from 12 to 220 v input. **Carter Motor Co, 2700 W George St, Chicago.**

Circle 130, Reader Service Card

Math reference card . . .

is the first of a series condensing mathematical formulas and tables. Card is approximately 3 x 5 in. Tables of three-place logarithms of numbers and functions of angles are given together with formulas from algebra; geometry and trigonometry including definitions; special right triangles; law of sines, cosines and tangents and arithmetic progression. Single card is 50¢. **Redi-Reference Card Co, 35 Corchaug Ave, Pt Washington, NY.**

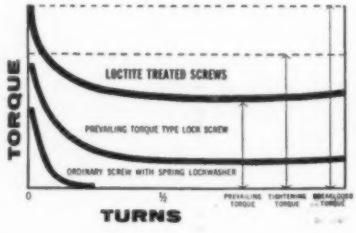
Circle 131, Reader Service Card

Stake screws with LOCTITE ...a retaining compound designed for thread locking!

Insulating varnishes and mechanical punching have been widely used for years for the lack of a better method. Now there is a retaining compound designed specifically for thread locking. Consider these advantages:

1. LOCTITE provides complete resistance to loosening under shock or vibration because it fills and locks engaging threads, providing *both* breakloose and prevailing torque.
2. LOCTITE has several times the holding power of locknuts or lockscrews because locking action extends over entire engaged surface and persists for several turns.
3. LOCTITE is easy to apply . . . not sticky . . . no mess . . . does not air dry! Hardens only in absence of air. Large batches of threaded parts can be treated and stored for days . . . lock only when assembled. No heating or mixing is necessary.
4. LOCTITE comes in different strengths which apply any required locking torque—ranging from a light drag suitable for adjustment screws to a locking force exceeding the torsional strength of the screw. Provides greater uniformity than mechanical staking.

LOCKING CHARACTERISTICS OF LOCTITE



LOCTITE is a thin liquid that hardens when confined between closely fitting metal parts. It forms a tough, heat and oil-resistant, bond that secures threaded parts better than any mechanical locking device. Write for literature and free sample.

LOCTITE® SEALANT
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119 Woodbine St., Hartford 6, Conn.
In Canada: J. S. Parkes & Co., Ltd., Montreal

CIRCLE NO. 82 READER SERVICE CARD

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NEW LITERATURE

Automation from Three Viewpoints

Commentary on automation runs all the way from, "automation is the magical key to creation" to "just more of the same kind of stuff which has been taking work out of work." Here are three authors, each eyeing this revolution from a different angle . . .

• from a management consultant . . .

JOHN DIEBOLD. Automation: Its Impact on Business and Labor. National Planning Assn, 1606 New Hampshire Ave, NW, Washington, DC. Paperbound, 9 x 6, 64 pp. $1.

"Automation is a way of thinking as much as it is a way of doing," says the author. "For the first time it is practical to look at an entire production or information handling process as an integrated system and not as a series of individual steps." It is for this reason, claims the author, that automation will have a profound effect on our society, our economy and the structure of our industry. The framework of this discussion is built around the present applications of automation and a brief look at the industries where it will be playing a continually increasing role.

• from a computer specialist . . .

ANDREW D BOOTH. Automation and Computing. MacMillan Co, 60 Fifth Ave, New York 11. 6 x 9, 156 pp. $5.

The computer, whether analog or digital, is the heart of the feedback loop that distinguishes an automated process from one that is simply automatic. The computer can make logical decision and thus, can perform some of the simple tasks previously performed by man. Here is a detailed study of those computers from a mathematical and electronic point of view, and a discussion of how they are applied to such typical automation projects as: the control of continuous processes, automatic machine tools and assembly processes, routine clerical work.

• from England . . .

L LANGDON GOODMAN. Automation Today and Tomorrow. Iota Services Ltd; distributed by Newman Neame Ltd, 50 Fitzroy St, London W 1, England. 6 x 9, 275 pp. About $5.60.

Although it is assumed that automation will have a marked effect on our economy and the way we live, it is the technical impact that is presently making itself felt. Here is a review of some of the more important applications in England and the United States. The author discusses both the broad applications such as processing methods, automatic assembly, industrial finishing, inspection, as well as specific industries: machine tools, chemicals, coal mining, motor cars, tapered roller bearings. An extensive bibliography (150 pp) is a major part of the book. —CJL

STAINLESS AND NYLON FASTENERS—Handbook and catalog, 180 pp. Catalog price list also contains basic data on fasteners, as well as stainless steel and nylon. Covers over 12,000 standard, stock fasteners. Anti-Corrosive Metal Products Co Inc, Castleton-on-Hudson, NY.

Circle 140, Reader Service Card

METALS FOR CORROSIVES—Calculator. Shows preferred materials for 247 different types of corrosives. Also, jacket of slide-rule type calculator lists and illustrates some of Hoke's fluid control products for handling corrosive fluids. Hoke Inc, 197 Piermont Rd, Cresskill, NJ.

Circle 141, Reader Service Card

PRODUCTION FACILITIES—Brochure, 8 pp. Engineering, experimental and development, production, assembly, quality control facilities for production of special products are described and illustrated. Also, 100 products already produced. Dill Mfg Co, Special Products Div, 700 E 82nd St, Cleveland 3.

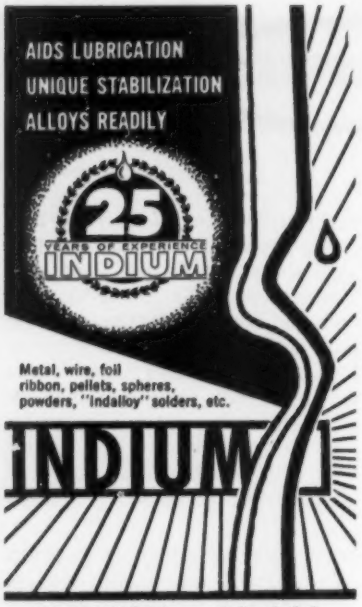
Circle 142, Reader Service Card

FIELD SERVICE CAPABILITIES—Booklet, 8 pp. Outlines field services offered on world-wide basis in areas of field engineering, overhaul and repair, test equipment, standards, training and medical electronics. Hoffman Electronics Corp, 3740 S Grand Ave, Los Angeles 7.

Circle 143, Reader Service Card

DRAWING AIDS AND EQUIPMENT—Catalog and reference chart, 12 pp. Indexed catalog contains descriptions of every product and charts for such things as decimal equivalents, architect symbols and tap drill sizes. Alvin & Co Inc, 611 Palisado Ave, Windsor, Conn.

Circle 144, Reader Service Card



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ELECTRONIC DESIGN AND PRODUCTION ENGINEER

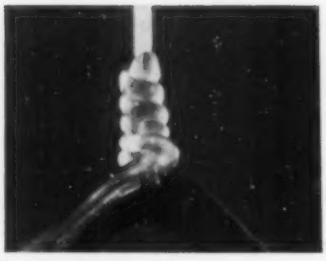
Unique opportunity for an electronic engineer with at least 5 years' experience in production line assembly techniques. This man must be able to adapt designs of electronic equipment in kit form to assembly line operations. He also will develop testing, alignment and inspection procedures. Experience in radio, television, tape recorder or phonograph industry is required. Supervisory experience is preferred. Starting salary of $8,000 to $10,000, depending upon background. Relocation expenses paid. Outstanding benefits program. Send resume in confidence to D. J. McNamara, Personnel Manager.

HEATH COMPANY
BENTON HARBOR, MICHIGAN
A Subsidiary of Daystrom, Incorporated

For Your Information (personal)

Tieing 'em up and tying 'em down

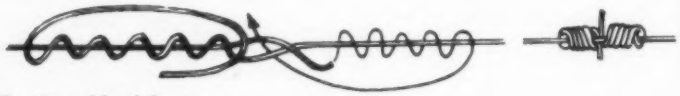
The Navy is abandoning its long-time love, sisal rope; now stocks nylon mooring lines for submarines, expects soon to make them available for destroyers as well. Private boat operators, already using nylon, are now eying Dacron and polypropylene. And fish are getting it three ways—with lines of all three synthetics coming on the market.



Caution signs . . . for knot-users are narrowing at base of knot and flattening of filament around mandrel. To minimize danger of failure, knots should have a number of turns, should be pulled up snugly.

There are tricks to using the new lines, though, as DuPont points out. They differ in weight, elongation, and knot-holding ability. DuPont has been making a scientific study of knot-tying using electronic tensile testers and high-speed movies. Result: the recommendations pictured here. The improved clinch knot is recommended for joining spinning lines and leaders to flies and bait hooks; and the blood knot for tying two lines together, with the end loop as an alternate. The company has also prepared several technical bulletins on nylon and Dacron ropes, giving strength, abrasion resistance, extension, recovery, and other properties. These are available from the Technical Service Section of its Textile Fibers Dept in Wilmington, Del; or by circling No. 200 on Reader Service Card. —ARG

To tie a clinch knot . . . double end back from eye of hook and take 5 turns around standing part of line. Thrust end between eye and first loop; then back through big loop, as shown. Pull up tight. Cut off end at ⅛ in.

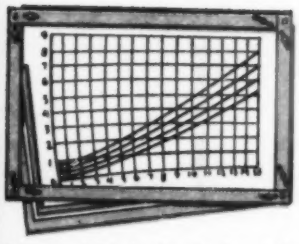


To tie a blood knot . . . lap ends; twist 5 times; tuck end back and hold. Repeat at opposite end as shown, taking 5 twists in same direction. Push end through center of lap. Pull up tight, allowing turns to gather.

To tie an end loop . . . form a double strand 4 to 6 in. long. Fold the u-shaped bend back and spiral it around itself 5 times as shown. Then, insert end through first loop and pull up as tight as possible.

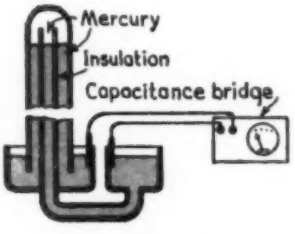
Why Don't They

R ESEARCH and D EVELOP . . .



. . . a membrane material for plotting graphs that will permit axes to be stretched to any reasonable length after the curves are plotted. This way, a curve could be reproportioned to a more appropriate scale without replotting. An elastic material stretched over an adjustable frame might do the trick. After plotting, a contact print could be made by conventional diazo processes. Such a material would also be valuable when a family of curves, plotted on the same axes, are nicely spaced at some points but too close to read at others. Skewing the grid pattern would spread those that were close, without stretching those that are already widespread. —F DEPEW

. . . a lawn seed sprayer attachment for a garden hose. Operating on the venturi principle, it would draw seeds and fertilizer mixture from a container and spread them evenly on the lawn along with the water. Seed should be a type that would penetrate the soil without needing to be raked. —V GRASER



. . . an electronic system for measuring mercury columns. This has application in temperature and barometric monitoring. It could be accomplished by resistance change of a slide wire resistor in a mercury column, or by measuring capacitance of two radially concentric, but insulated, columns of mercury. —B. FUDIM

. . . mouldings and baseboards for homes that snap on or off like chrome trim on cars. This would greatly facilitate painting both walls and mouldings. The mouldings could snap to a special metal strip attached to the wall with screws or nails.—W PATTERSON

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Publisher's Postscript...

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"What has he published?"
"I read it in last week's issue . . ."

Have you ever thought how much of your technical conversation refers to the great body of engineering literature? Yet poor library research and inadequate awareness of other people's work still costs companies a fortune every year in duplicated R & D.

I often wonder why we're all so lazy about "looking it up." It's dusty work, sure, but it can't help being productive. As a matter of fact, the US could probably continue at the present rate of technological progress for years without any additional basic research, just by mining and combining what has already been discovered.

Calling this information to your attention is our responsibility as publishers. The problem is that the field of design cuts across so many specialties. Dynamics and mechanics, nuclear physics, electronics, plastics technology, statistics, and dozens of others all contribute to product engineering. To supply this information the editors have broadened their subject coverage and at the same time distilled each article to its essential information content. The articles are more fruitful reading to begin with—but they're more useful for the years to come as basic reference material as well.

The broadening of subject matter is very apparent as you leaf through our index of editorial content for the first six months of this year. In the subject index alone there are 1500 entries ranging from "adhesives" to "welding." There are more than 700 company references under "organizations"; nearly 200 authors in the authors' index.

You'll find every engineering subject covered in breadth —and in depth: linkage spring design, how to use adhesives, a suggested engineer's bookshelf, motor and fan selection, stress analysis, gear standards, plus how to read faster (and in this issue, how to write better), and how to organize and how to control engineering projects.

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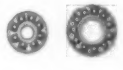

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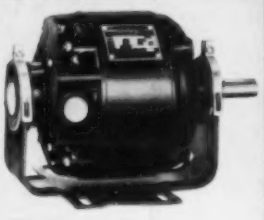

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